

JULY 20, 1961

MACHINE

DESIGN

A PENTON PUBLICATION — BIWEEKLY

Chemical Cleaning

Contents, Page 3

MR. STEVENS RICE
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No place for guessing games!

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CORPORATION OF AMERICA**
A BIRFIELD COMPANY

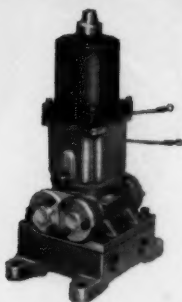
Pioneer in Powder Metallurgy Bearings and Parts • Plants at Bound Brook, N.J. and Sturgis, Mich

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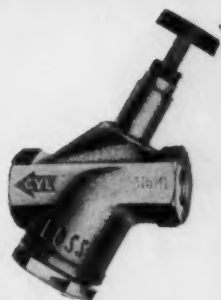
The stock shelves at **Ross** include more different air valves than any other stock shelves in the valve world

Do you know these air controls by **Ross**?



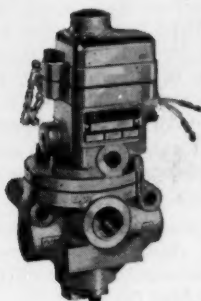
50 Million Cycles in Tests

Ross Goldmodel. A lightning fast, base mounted valve with its solenoid immersed in oil to run cool for long, long life. Full JIC. 3-way, 4-way and 4-way 5 port models. $\frac{1}{4}$ " through $1\frac{1}{4}$ ".



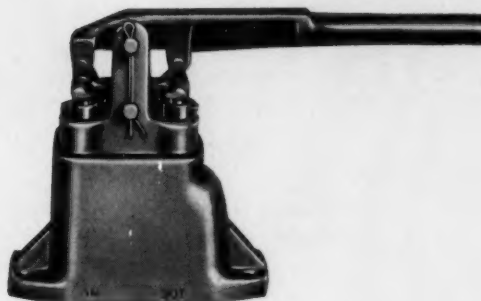
Control Cylinder Speed

Speed Control Valve. The adjustment screw directs air through an orifice that's engineered to give fine shadings of control at either high or low flow rates. $\frac{1}{4}$ " through $1\frac{1}{4}$ ".



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"Headline Series". Highest capacity valve-size for valve-size of any valve we've seen. Use a smaller, economical inline valve to do a bigger, more expensive valve's work. Fast. S-way, 3-way, 4-way. $\frac{1}{4}$ " through $1\frac{1}{2}$ ".



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Ross #100 series. Rough, tough jobs call for this valve which can pass most dirt and foreign matter with no trouble. Few moving parts and short poppet travel makes it especially wear resistant.

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 109 E. GOLDEN GATE • DETROIT, MICHIGAN





sea-going pinions... alloy steel of course

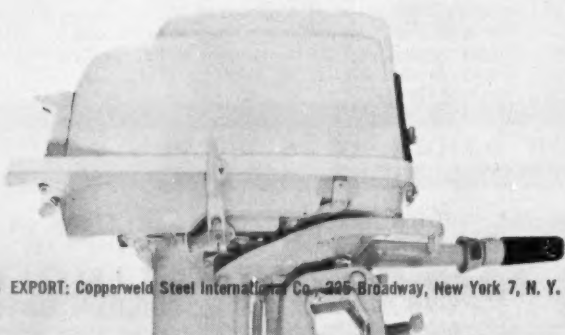
This small pinion gear operates under man-size loads. A vital part of the gear case assembly for an outboard motor, it must stand up under extreme stresses and strains—yet its size is restricted by compact design. OUTBOARD MARINE CORPORATION* selected Aristoloy 8620—added strength without increasing bulk or weight. They report that this *electric furnace* alloy machines, drills, and broaches easily—yields parts of uniform, smooth finish—and, most important, the strength and hardenability characteristics after heat treatment, which they required.

For more information about Aristoloy bars and billets, call your nearest Copperweld representative—or write today for PRODUCTS and FACILITIES CATALOG.

*Manufacturers of Johnson, Evinrude and Gale Outboard Motors.



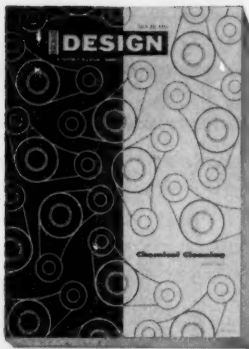
DIVISION OF
COPPERWELD
STEEL COMPANY



ARISTOLOY STEEL DIVISION



4017 Mahoning Ave., Warren, Ohio • EXPORT: Copperweld Steel International Co., 225 Broadway, New York 7, N. Y.



Front Cover: "Out, out, damned spot!" might be the theme for the cover by artist George Farnsworth. Author Lester Spencer gives us a much more practical interpretation beginning on Page 134.

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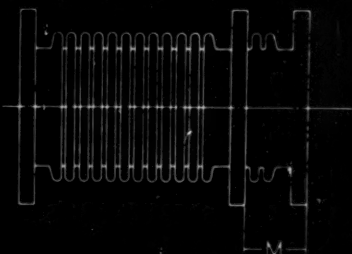
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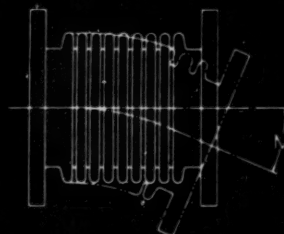
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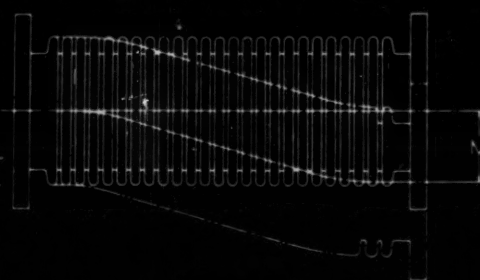
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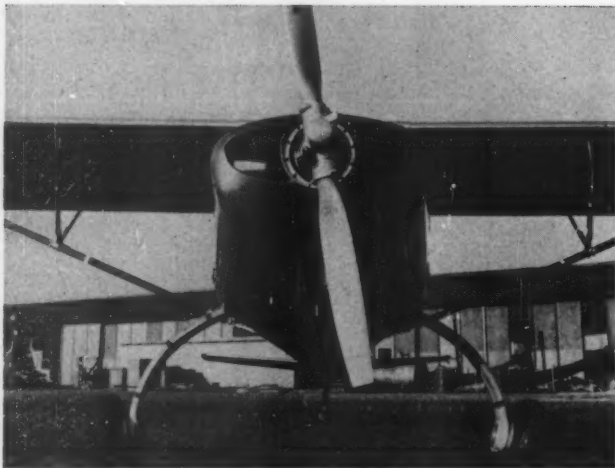
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Sandwich-Constructed STOL Lands on Glass-Fiber Gear



Glass-fiber landing gear on the new MFI-10 takes terrific test beatings. Designed to resist stresses encountered when landing on rough ground, the gear has surpassed all expectations. Even though optimum design has not yet been achieved, it has outperformed conventional types in all respects. Shock absorption and damping characteristics are better, and the plane rides more smoothly on the ground, despite the fact that landings have been deliberately rough. In addition, honeycomb construction of wings, control surfaces, and fuselage—a second radical innovation in the aircraft—has improved aerodynamic characteristics of the experimental STOL. Aluminum-alloy sheets, bonded to a honeycomb spacer, provide lightweight surfaces that are both firm and precise. Weight savings and aerodynamic cleanliness of the lines are credited with upping the aircraft's top speed considerably.



MALMO, SWEDEN—The MFI-10, an experimental STOL aircraft now being tested in Sweden, boasts two airplane-industry firsts: Its landing gear is made from glass-fiber reinforced plastics, and sandwich construction is used in fuselage, wings, and control surfaces. Developed by AB Malmo Flygindustri, subsidiary of Trelleborg Rubber Co., the four-passenger airplane was first intended as a research vehicle, but its high performance may force it into production when prototype testing is complete.

Because the airplane often lands on very rough terrain, the undercarriage is designed to withstand more than the normal amount of stress. Numerous test landings have proved that glass-fiber minimizes bouncing and has better damping and shock-absorbing properties than the usual undercarriage materials. By providing a smoother ride on the ground, the undercarriage causes fewer vibrations to be transmitted to instruments.

Glued-On Gear

The major problem in developing the new landing gear had to do with anchoring it to the load-carrying members of the airplane. The method adopted involved bonding wedge-shaped glass-fiber plates to the undercarriage spring and internally attaching them to steel fittings in the fuselage.

The MFI-10 is claimed to be about 10 per cent faster than low-winged aircraft with non-retractable landing gear and the same load capacity. Its maximum speed (150 mph) and high rate of climb (1000 fpm) are due largely to aerodynamic advantages gained from the sandwich construction and from low weight of the aircraft.

Aluminum-alloy sheets bonded to each side of a honeycomb aluminum spacer make up the sandwich. The material provides smoother surfaces and greater precision of shape, according to ABMF spokesmen, and permits low manufacturing costs, particularly for long production runs. Development work is continuing to further decrease weight.

... Fluid Power news



Report No. 11,602 From Oilgear Application-Engineering Files

HOW OILGEAR ENGINEERING TEAMWORK AIDED DESIGN OF NEW INJECTION MOLDING MACHINES

CUSTOMER: National Automatic Tool Co., Inc. (NATCO), Richmond, Indiana

DATA: As a preliminary guide to design and production of a new line of injection molding machines, "NATCO" engineers used a 31-question survey of molders operating eight or more machines. This survey confirmed "NATCO" engineers' experienced opinion that: 1. Most unplanned downtime on injection molding machines was due primarily to hydraulic system problems . . . shocks caused by sudden shifts in pressure or direction of flow through valves "under pressure," causing pipe and welded joint fatigue, bent valve stems, cracked or over-stressed tie-rods and cylinders. 2. Molders' demands for higher speeds and

pressures further amplify these problems. **Basic "NATCO" Requirements:** 1. A hydraulic system to eliminate shock, hammering, and the resulting costly downtime . . . must provide continuous, dependable, high-speed operation. 2. Both slow and high-speed closing, as well as two-speed injection control for faster molding cycles. 3. High-speed clamp action. 4. Precision control of speeds and pressures to insure high molding quality. 5. Must be a "clean" package . . . compact, leak-free, simple to install, fast and easy to maintain, quiet, conserve electrical power.



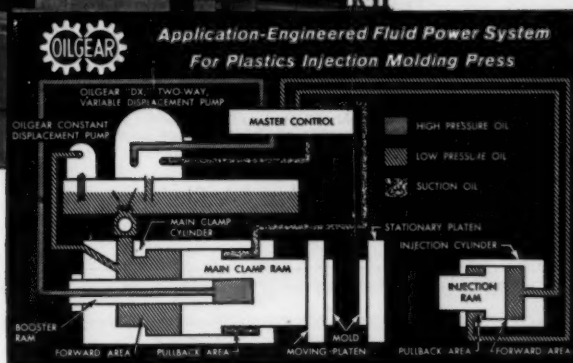
New "NATCO 400" Plastics Injection Molding Machine — one of four standard sizes. Note overhead position of the Oilgear pump and reservoir . . . away from dirt and molding-room traffic. This position permits fast gravity flow of oil from the reservoir through a prefill valve into the large clamp cylinder to speed operation. During the past year . . . a period of unusually low capital investment purchases . . . over 150 Oilgear Pumps have been put into operation on this new "NATCO" line.

SOLUTION: Cooperation and teamwork between "NATCO" and Oilgear engineers resulted in a new, shockless, *Fluid Power System* . . . basis of a revolutionary new line of high-speed, high-capacity, plastics injection molding machines. This system incorporates two Oilgear Pumps . . . one, a large capacity, radial piston, two-way, variable displacement type "DX" pump with remote electric control which alternately serves the mold clamp and injection rams; and a small capacity, constant displacement type "HG" pump which maintains a high, positive clamping force during injection cycle. Instead of using conventional valves "under pressure" to reverse clamp and injection rams, these functions are accomplished by reversing fluid flow in the Oilgear type "DX" pump. With this system, flow and pressure decelerates to zero before flow direction is changed . . . flow then accelerates to a preselected volume in the new direction — completely eliminating reversal shocks. No chokes or other controls on the master valve are necessary, as diverting of flow from clamp to injection rams is also made under ideal "no-flow" conditions, with absolutely no shock. Infinitely variable machine speeds are obtained by varying pump stroke, resulting in a minimum of heating and horsepower dissipation.

For similar practical solutions to **YOUR** linear or rotary Controlled-Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems
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Simplified schematic illustrates one phase of system operation — high-speed closing of clamp ram. Large clamp cylinder is being gravity-filled through prefill valve, while mold clamp is being advanced by small booster cylinder powered by Oilgear "DX" pump. Closing speed — 700 in./min. This circuit design provides clamp pressure build-up in a fraction of a second . . . one of the reasons for the fast cycles on the "NATCO 400."

"NATCO," famous in machine tool and plastic molding machine fields, states — "Although lower priced pumps could be secured, they basically did not offer the control features found in the Oilgear units. This is especially true of the larger capacity pump, which in addition to its variable and reversible features incorporates many auxiliary controls. It's more than just a pump . . . it contains auxiliary systems for pilot, supercharge, cooling, safety, and filtering. These pumps are quiet. They have an excellent injection molding machine service record . . ."

Engineers' Starting Salaries Take Another "Predictable" Hike

A GAIN this year, fledgling engineers are starting their professional careers better paid than any previous beginners. According to data turned up by a MACHINE DESIGN spot check of eight* top engineering schools, new graduates are now averaging \$43 per month over the '59 pay level (MD did not conduct a survey in 1960). For the last ten years, starting salaries offered to beginners have increased so regularly that student engineers could be pardoned if they extrapolated the curve into the future to see what the market will bring when they graduate.

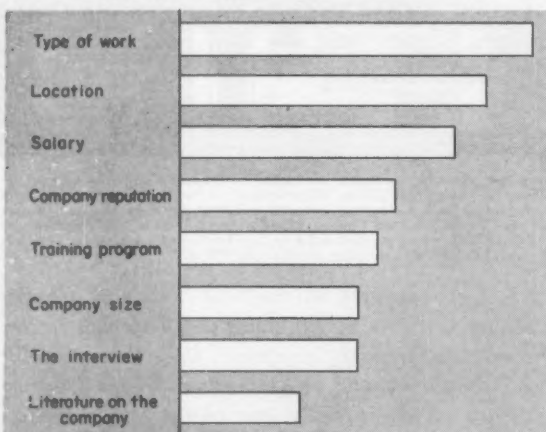
While sampling for the survey was not large, in past years similar samplings have agreed well with more extensive efforts. In most cases salaries noted in the spot checks have been within one or two per cent of those resulting from large surveys.

Starting pay for engineers and scientists coming out of graduate school (with no or little work experience) is appropriately higher than that of B.S. holders. New doctors command about \$275 per month more, and the master's degree brings in an additional \$100.

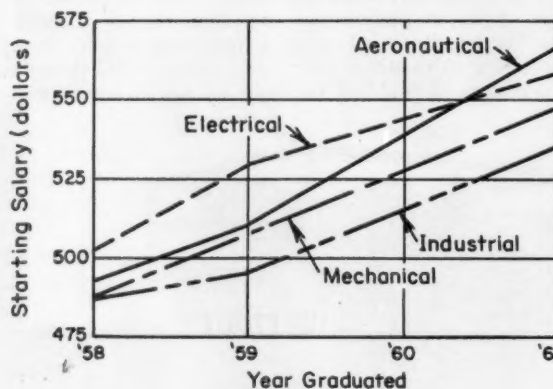
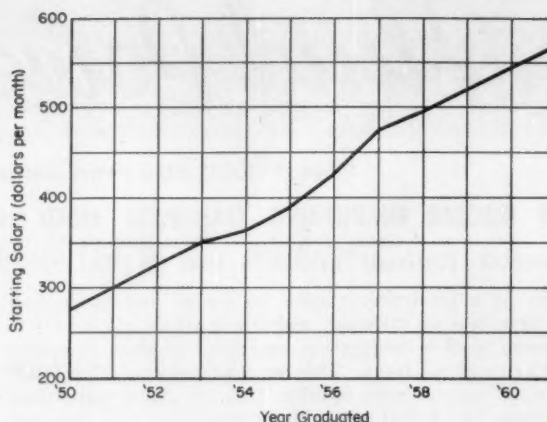
Demand for aeronautical and electrical/electronic engineers appears greatest, and these types, together with metallurgicals and physicists, are starting out at the highest salaries. The electrical engineers, however, seem to have lost some of the salary edge that was evident two years ago. Mechanical and industrial engineers are starting at slightly less salaries, although they too are up \$40-50 from two years ago. Rounding out the picture, chemical engineers are making about the same as the mechanicals (although the latter show a wider spread); civils are not quite as well paid. All averages

*Massachusetts Institute of Technology; Columbia University; Lehigh University; Case Institute of Technology; University of Michigan; Northwestern University; University of California, Los Angeles; Georgia Institute of Technology.

Factors Influencing Job Choice



When asked to rate eight factors, most college-placement directors agreed type of work offered was the biggest influence on new grads' job selections. Company location and reputation and salary were also important.



reported by the colleges are now over the \$500-per-month plateau.

New grads had little difficulty finding jobs this Spring. The number of recruiters who set up shop at the colleges remained about the same—some say there were a few more; some less—and these men were more selective than in previous years. According to one return, "our engineering school harvested 3.4 offers per student, as compared with 5.2 last year."

Recruiters preferred to fill job openings with candidates from the upper 10 per cent of the classes, and in some cases they offered \$50 per month more for them. While the recruiters were quick to sign up all those in the upper 25 per cent, graduates with lower averages usually found themselves in weak bargaining positions.

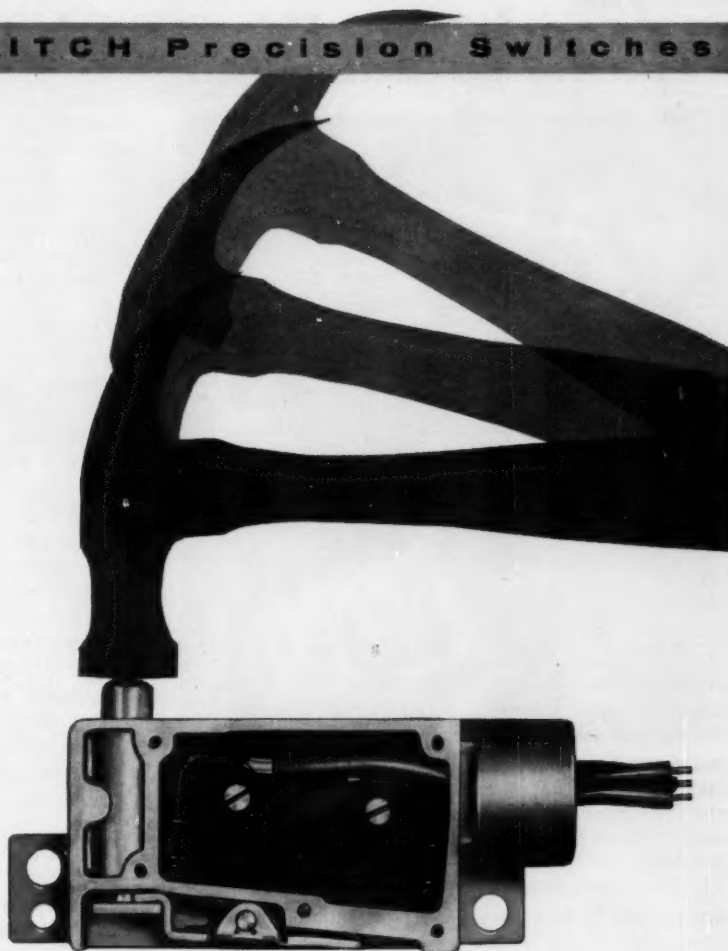
Average Starting Salaries Reported by Eight Colleges

Curriculum	—1959—		—1961—		Average Increase (per cent)
	Low	High	Low	High	
	(dollars per month)				
Aeronautical	485	510	556	585	14.7
Metallurgical	475	535	537	581	10.7
Chemical	480	510	539	557	10.7
Eng. Physics	500	540	554	590	10.0
Industrial	480	510	525	551	8.7
Mechanical	490	525	521	569	7.4
Electrical	510	550	546	585	6.7
Civil	470	510	500	545	6.1
All Engineers	495	535	542	575	8.5



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ROLL
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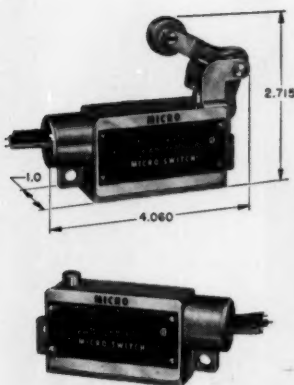


HAMMER-BLOW HERE

Impact actuation of the external plunger is absorbed by a specially designed operating mechanism.

FEATHER-TOUCH HERE

A controlled force is transmitted to the diaphragm-sealed plunger of the internal switching unit.



Plunger Actuator switches and Roller Arm Actuator switches are both available in either left hand or right hand designs.

The MICRO SWITCH "LN" Switches are compact, but rugged! The high-strength enclosure and the special design of the actuator combine to withstand rapid, hammer-blow operation. A diaphragm completely seals the actuating plunger. The No. 14 insulated leads are sealed at the conduit hub. A gasket inside the cover completes the seal against oil and dust.

Two contact arrangements are available: single-pole double-throw and two-circuit double-break units. Check the compact size and you'll find that "LN" Switches fit where other switches can't! See the Yellow Pages for the nearby MICRO SWITCH Distributor or write for Catalog 83.

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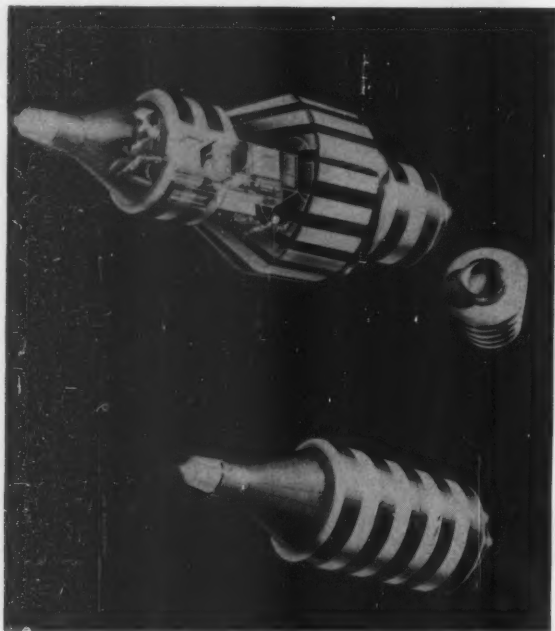
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Honeywell
MICRO SWITCH Precision Switches

Best Place to Design Spaceships: Space



Typical spacecraft may be built in three sections. Command center (in front) would be a highly secure, rigid structure capable of re-entry. Propulsion section (center) would contain power for orbital correction and have a retro-rocket for re-entry. Living shelter and laboratory (rear) could be packaged within a van module.

NEWPORT BEACH, CALIF.—Despite great advances in environmental test equipment, the best laboratory for testing designs and materials for spacecraft is space itself. This is the view of scientists at Aeronutronic Div., Ford Motor Co., who are conducting studies of semi-rigid and non-rigid manned space structures.

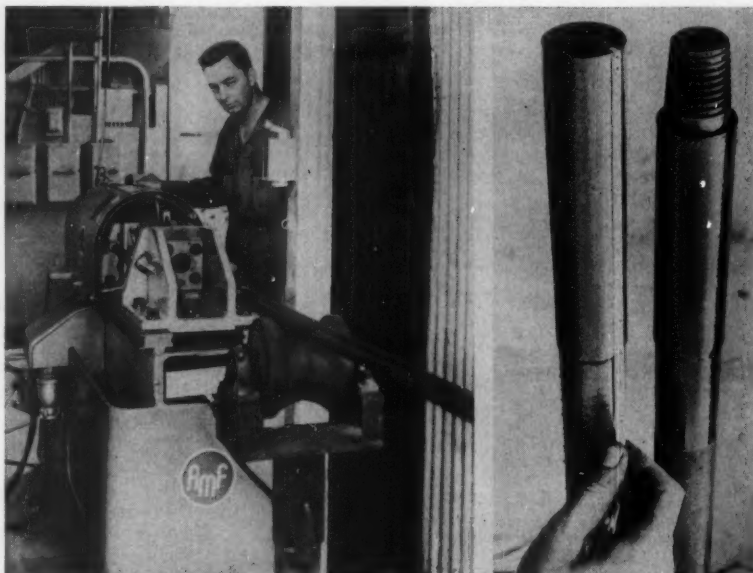
Design of a manned spacecraft requires information on how various materials will survive in space, plus the ability to fabricate craft that will fulfill the assigned tasks. According to Dr. Seymour Lampert, project coordinator, "it would be desirable to obtain answers to all our space problems right here on earth, but this is not possible. For one thing, we can't always test materials under properly simulated environments, since the significant parameters associated with these environments are not well defined. For another, by the time we are able to build expensive test apparatus, we will have obtained many of the answers from space probes."

The Aeronutronic scientists are studying three general structures for spacecraft: Pressure-stabilized membranes, "space shingles," and telescoping modules. Use of the membranes will depend on how well multilayer plastics or rubberized materials can meet conditions encountered in space. The space shingles would be rigid panels—curved or flat, interlocking or overlapping—which would supplement flimsy membrane structures and provide necessary armor. However, sealing of the panels is a problem. When deployed, the telescoping modules would be attached to the space cab and strung out behind. They could be used as inflated storage compartments, instrumented packages, or communications balloons such as Echo.

Friction Welding Goes to Work

OKLAHOMA CITY, OKLA. — First known use of friction welding in the U. S.—on a production basis—is reported by American Machine & Foundry Co. The project involved the welding of tool joints to 30 ft lengths of 1¼-in. tubing. Twenty welds were made per hour (average rate) and about 15,000 linear feet of tubing and 1000 welds were involved.

The prototype machine, developed by American Iron and Machine Works Co. Inc., an AMF subsidiary, resulted from a two-year study of the basic principles of friction welding. It uses light pressures and high speeds to produce welds that are applicable to a vast range of materials and suitable geometries. AMF plans to develop improved models of the prototype and continue its study of friction-welding basics. Company spokesmen say that future, more advanced machines will operate at much higher speeds.



Data show the friction-welded joints are competitive with threaded and coupled joints and with pressure welding. Despite natural handicaps of any prototype operation, the speed of the machine was comparable to that of flash welders and far exceeded pressure welding and other methods.

NEW DEPARTURES IN MINIATURE



ULTRA-CLEAN INCUBATORS FOR M/I* BALL BEARINGS

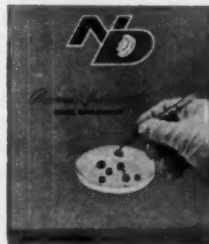
N/D'S NEW WHITE ROOM PROVIDES ULTRA-CLEAN ENVIRONMENT FOR M/I BALL BEARING ASSEMBLY

N/D announces a new White Room at Sandusky, Ohio incorporating the latest technological advances available today. This new room provides a virtually dust-free atmosphere so necessary for the production of Miniature and Instrument Ball Bearings of high reliability.

Environmental controls within the room hold temperature to plus or minus 1°... with maximum relative humidity only 40%. Final air filtration into room removes particles larger than 3/10 micron. A complete air change is made every three minutes. All authorized personnel entering the room are thoroughly bathed by air showers in two successive deduster chambers.

You can benefit from New Departure's 25 years of experience in M/I ball bearing production by calling your nearby N/D Sales Engineer. Or write Department L.S., New Departure, Division of General Motors Corporation, Bristol, Conn.

*Miniature and Instrument Ball Bearings.



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NEW DEPARTURE

MINIATURE AND INSTRUMENT BALL BEARINGS

Infrared Binoculars Pass Their Tests

New Epoxy Adhesive Keeps Seals Tight

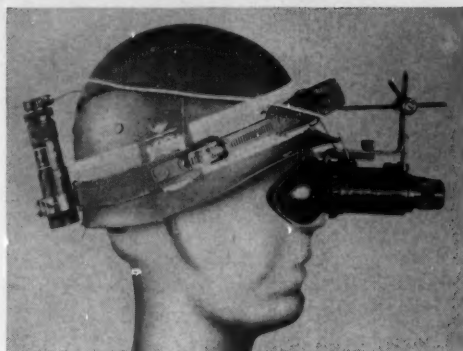
LANCASTER, PA. — Binoculars that will let soldiers see in the dark may soon become general-issue equipment. Under development for some years, infrared binoculars can now resist hard usage. Until recently, the adhesive seals between lenses and plastic housings did not hold up well, usually breaking down in the field.

The new binoculars differ from ordinary ones in that they require an infrared converter tube in addition to other optical elements. Seals must be absolutely tight and must withstand across-the-face operating voltages of 12,000 v (before final assembly the glasses are tested at 19,000 v). In addition, the seals must remain resilient and not crack either glass or plastic as ambient temperatures change.

The newest test models of the binoculars use J-1158 epoxy resin, developed by Armstrong Cork Co. To date, no seal failures have been reported. Both base epoxy and catalyst are packaged in one tube, the catalyst in a smaller internal tube. Before use, the small tube is broken and the catalyst kneaded into the base. After mixing, the large tube acts as an applicator.



Early models of infrared binoculars did not remain in service long. After several months of field usage, seals developed leaks and broke down under the 12,000-v potential necessary to drive the IR converter. The binoculars are being developed at the Army's Fort Belvoir, Va., facility where they are tested under the worst of conditions.



The Shrinking Transistor—Key to Pocket-Size Computers?

NEW YORK—Transistors have now "grown" so small that 20,000 of a new type fit on a postage stamp. Developed by Radio Corp. of America, the new components, made by evaporation-depositing of thin films on an insulating base, are capable of shrinking computer circuitry to the size of a book page. Contemporary-computer circuitry requires a volume at least as big as a large hat box.

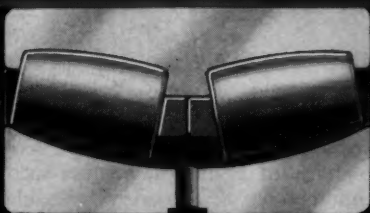
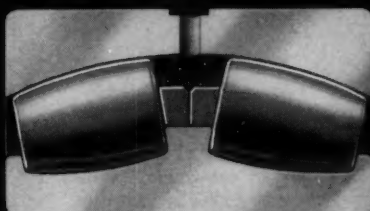
Believed to be the first time that transistors with useful performance characteristics have been produced by thin-film evaporation techniques, the development fits in with present methods of making other thin-film devices. Thus, it points the way to low-cost mass production of entire

circuits containing thousands of active elements, all connected and ready for operation. Ultraminiature circuits for many applications could result. Thin-screen, wall-type television receivers are one example cited by RCA spokesmen, and three-stage amplifiers could be produced on a surface as narrow as a human hair.

The new transistor is made by depositing successive thin layers of cadmium sulfide—a compound with considerably greater insulating properties than germanium, silicon, and other semiconductor materials used in standard transistors—and metal on a glass plate. Measuring only a few ten-thousandths of an inch thick,

the component does not work on the usual principles. In conventional transistors, electrons flow more or less freely through the semiconductor material between two contacts, and the third element provides control by reducing the flow in varying degrees. The operating principle of the experimental thin-film transistor is exactly opposite. Insulating properties of the cadmium sulfide hamper the flow of electrons between two electrodes, and the third element provides control by increasing the flow in varying degrees. This innovation, it is said, could permit extreme simplicity in circuits and allow tiny devices to be linked in large arrays.

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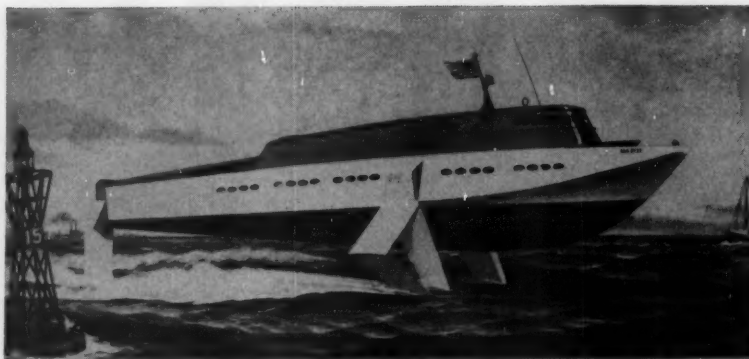
Fast U. S. Hydrofoil May Revamp Marine Travel

WASHINGTON—H. S. Denison, the first hydrofoil craft designed specifically as an oceangoing vessel, will take to the water late this summer. The ship is being built under a Maritime Administration contract with Dynamic Developments Inc., an affiliate of Grumman Aircraft Engineering Corp.

Constructed of aluminum alloy, the 104-ft hydrofoil will be capable of carrying a payload of 37 tons. It has a displacement of 80 tons.

During foil-borne operation, Denison will be powered by a General Electric MS-240 gas-turbine engine rated at 19,000 shp. Power for displacement operation is furnished by a smaller GE YT-58-2 gas-turbine driving two water-jet pumps. Located aft on either side of the hull, the pumps provide a maximum displacement speed of 8 kt.

Designed to cruise at 60 kt, Denison will "take off" fully loaded at



Traveling on sub-cavitating foils, H.S. Denison will be limited to 60-kt speeds. Development program calls for installation of supercavitating foils within two years, which should boost the ship's performance to 100 kt. The craft is already equipped with a relatively new supercavitating propeller.

a speed of about 30 kt. While foil borne, and traveling at top speed, the craft will have a turning radius of 1000 ft. Design hull clearance is 5 ft above the water, permitting the craft to operate in 5 to 7-ft waves without undue slamming.

Among the many experimental test programs performed during Denison's development, the construction of a dynamically similar manned model has been one of the most interesting and successful. Ap-

proximately 22 ft long, and powered by a motorcycle engine, the model carries one man aboard and is capable of performing, within limits, all of the functions of the larger craft.

According to sources in the Maritime Administration, studies are now being made to determine the feasibility of constructing much larger hydrofoil craft—displacements of 500 tons and over are being actively considered.

\$2.98 Polaris Sub Aggravates Admiral Rickover

WASHINGTON—Security measures, or more accurately the lack of them, surrounding many of the nation's first-line defense weapons have recently become a subject of major concern to many high military and government officials.

One of the latest rhubarbs centers around the Navy's Polaris submarines. Involved are: Outspoken Admiral Hyman G. Rickover; a \$2.98 scale-model submarine which is available in kit form; and the Congressional Joint Committee on Atomic Energy. Testimony by Admiral Rickover, in answer to questions by the Committee, reveals the peculiar state of affairs that exist today in the matter of military security:

Congressman Westland. Admiral, would you care to discuss the security problems?

Admiral Rickover. Ever since Mr. Westland saw the plastic model of the Polaris submarine, which can be bought at any dime store, he

questioned the propriety of releasing such information. I told him that I not only had nothing to do with the release but that I had recommended against it, because such information is extremely valuable to a foreign power. That information was handed out by the Navy. In fact a sheet of instructions accompanying each of these \$2.98 models states that it is built in strict accordance with official Navy blueprints; that the Electric Boat Co. furnished complete and accurate data; that it is a complete and authentic accurately scaled model incorporating all the interior details of the actual submarine. If I were a Russian I would be most grateful to the United States for its generosity in supplying such information for \$2.98.

Congressman Westland. Is that right? Is the scale right?

Admiral Rickover. Yes; it is right. Of course, there are deviations, but there is much that is correct.

Interservice Rivalry Boon to U. S. Enemies

Congressman Westland. You don't believe that that \$2.98 job should be for sale, do you?

Admiral Rickover. I certainly do not, sir. Further, it is very difficult to get our manufacturers not to advertise and show pictures of various pieces of equipment they build for these ships. This is a serious problem; we should have a more realistic rule on classification.

Today we must do much of our work—particularly manufacturing some of our components—on an unclassified basis. This is because we use existing industrial facilities which also make valves, boilers, pumps, and the like for other people. We couldn't possibly meet the requirements of the Armed Forces Security Manual for guards, fences, personnel clearances, safes, and so on for all of our equipment made in these factories without inordinately adding to the cost.

Congressman Price. This information was released and made available to the toy manufacturer because it didn't reveal any reactor technology. Was just as important information revealed?

Admiral Rickover. Yes, sir; the dimensions of the ship were revealed, including the relative size of the reactor compartment and the machinery compartment. I was asked to release this information. I wouldn't do it. But a great deal of information has been released on the details of our machinery plants. I refused to make this public but it was released anyway.

Congressman Price. Do you tell a lot of information when you give the size of the reactor compartment?

Admiral Rickover. Yes, sir; you certainly do . . . of course there are some errors in it. But a good ship designer can look at that model and quickly learn a great deal. He can spend 1 hour on that model and tell he has millions of dollars worth of free information. It also gives him an idea of how many men he could put into the ship and all sorts of other things. I just wouldn't do a thing like that. I see no reason why we should slave away and spend a lot of money and use up a lot of our talent and then just turn it over to a potential enemy. I'll ask you a question, sir: Can you conceive the Russians doing a thing like that? I certainly would like to have similar information on their submarines.

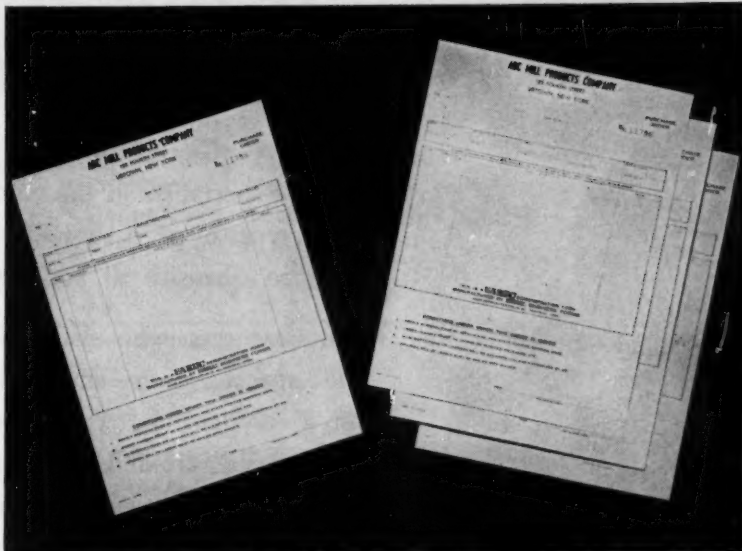
Congressman Westland. It is inconceivable.

Admiral Rickover. That's the answer right there, sir.

Congressman Price. Getting back to the fact that even though it doesn't reveal any information on the reactor itself, it does give some information on reactor technology—are you more concerned that those toys are of the Polaris than they are of any other type submarine and that it gives away your whole arrangement on the Polaris?

Admiral Rickover. Yes; I personally am aghast that this was done, but our internal military controversy is so great that there is a tendency for each service wholeheartedly to fight the others in order to achieve its own objectives. You know that most of the leaks result from this interservice fight, I am sure.

DRAFTING TRENDS



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Circle 212 on Page 19



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HELPFUL LITERATURE

Descriptions of items start on Page 184. Starred items are from July 6 issue.

Electrical, Electronic

- 502 Wire-Wound Resistors. 20 pp. Daven Co.
- 507 Linear Accelerometers. 4 pp. Fairchild Controls Corp.
- 511 Audio Transistors. 4 pp. Motorola Semiconductor Products Inc.
- 519 Plugs and Jacks. 16 pp. Cambridge Thermionic Corp.
- 524 Standard Switches. 4 pp. Donald P. Mossman Inc.
- 529 Waveguide Flanges. 16 pp. Microwave Development Laboratories Inc.
- 531 Variable-Speed Drives. 16 pp. Electro Devices Inc.
- 534 Magnetic Counter. 4 pp. Veeder-Root Inc.
- 544 Electronic Cooling Fan. 8 pp. Joy Mfg. Co.
- 545 Digital Transducers. 12 pp. Electronics Div., DeJur-Amsco Corp.
- 596 Low-Voltage Switchgear.* Features of 600-v switchgear with K-Line circuit breakers. Bulletin 3200-1A, 20 pp. I-T-E Circuit Breaker Co.
- 597 Digital Totalizers.* Models 521 and 522 operate at temperatures to 160 F. Bulletin D-212-A, 4 pp. Potter Aeronautical Corp.
- 598 Industrial Switches.* Applying limit switches; table of statistics on major switches; Lockswitch units. Catalog 201, 12 pp. R. B. Denison Mfg. Co.
- 599 Semiconductor Reliability.* Nomograph permits quick computation of acceptance number, success rate, and sampling plan. Semiconductor Div., Raytheon Co.
- 600 Electromechanical Devices.* Engineering, application data on selection of clutches and brakes, torque indicators, multispeed transmissions. Manual 360, 60 pp. Autotronics Inc.
- 601 Photocathode Characteristics.* Slide chart gives characteristics of 23 phosphors and 14 common cathode materials. ITT Federal Laboratories.
- 602 Temperature Transducers.* With temperature ranges of -435 to +1900 F. Product Note 3010, 4 pp. Trans-Sonics Inc.
- 603 Selsyn Indicating Systems.* Data for remote indication and remote control; applications of selsyn monitoring system; indicator arrangements. Bulletin GEA-7218, 6 pp. General Electric Co.
- 604 Fractional-Horsepower Motors.* Over 500 different general and special-purpose units listed. Bulletin PL-SB2820, 4 pp. Industrial Motor Dept., Westinghouse Electric Corp.
- 605 Vibration Inducers.* Specifications of both rotary and electrical units; lists various applications. Form 1044, 6 pp. Martin Engineering Co.
- 606 Transistor Heat Dissipators.* For a variety of sizes and types of power diodes and transistors. 4 pp. U. S. Heat Sink.
- 607 Indicators, Controllers.* Operation, applications of Thermo Electronic indicators and indicating controllers. Bulletin 67, 4 pp. Thermo Electric Co. Inc.

Hydraulic, Pneumatic

- 504 Pressure Regulator. 8 pp. OPW-Jordan.
- 508 Temperature Regulators. 8 pp. OPW-Jordan.

- 515 Servo Valves. 2 pp. Vickers Inc., Div., Sperry Rand Corp.
- 522 Flexible Metal Hose. 32 pp. Atlantic Metal Hose Co.
- 527 Cradle-Mounted Pumps. 4 pp. Ingersoll-Rand Co.
- 530 Leakproof Pumps. 4 pp. Chempump Div., Fostoria Corp.
- 532 V-Band Couplings. 8 pp. Marman Div., Aeroquip Corp.
- 535 Small Pumps. 4 pp. Moyno Pump Div., Robbins & Myers Inc.
- 538 Lubrication Equipment. 32 pp. Lincoln Engineering Co.
- 542 Motor-Operated Valves. 6 pp. Erie Mfg. Co.
- 608 Pressure, Vacuum Gage.* Construction features, operation, accessories available. Bulletin DH-S4, 32 pp. Helicoid Gage Div., American Chain & Cable Co. Inc.
- 609 Process Pumps.* Available in 72 basic combinations. Bulletin 1-210, 8 pp. Byron Jackson Pumps Inc.
- 610 Gate, Globe, Check Valves.* Descriptions, dimensional data for each unit are given. Catalog 10-B, 16 pp. R-P & C Valve Div., American Chain & Cable Co. Inc.
- 611 Solenoid Valve Selection.* For corrosive applications; lists over 500 corrosive chemicals, and gives selection charts. Catalog Manual 108, 16 pp. Valcor Engineering Corp.
- 612 Chemical Pumps.* Three models of cradle-mounted units cover range to 1000 gpm. Form 70288, 8 pp. Ingersoll-Rand Co.
- 613 Insulating Sleeving.* Hygrade SR-398, Class H sleeving operates to 400 F. 4 pp. L. Frank Markel & Sons.
- 614 Agitation-Equipment Drive.* TW drive provides quiet agitation in open or closed chemical vessels. Bulletin 1001, 8 pp. Pfaudler Co.
- 615 Diaphragm Valves.* Data on eight types of air operators for diaphragm valves. Bulletin 134-A, 6 pp. Hills-McCanna Co.
- 616 Lightweight Fittings.* Engineering details of new line for missile plumbing. 8 pp. Harrison Mfg. Co.

Mechanical Equipment

- 506 Worm-Gear Jacks. 24 pp. Joyce-Cridland Co.
- 512 Speed Reducers. 34 pp. Dept. SR, Hewitt-Robins
- 514 Flexible Belting. 12 pp. Extremultus Inc.
- 517 Flexural Pivot. 4 pp. Utica Div., Bendix Corp.
- 526 One-Piece Pulleys. 8 pp. Stephens-Adamson Mfg. Co.
- 617 Shaft Key.* Double-Taper Lock Key eliminates backlash, is self-aligning. 4 pp. Sure-Lok Co.
- 618 Differentials and Gears.* Solid and hollow-shaft units in wide and narrow design. 4 pp. Instru-Lec Corp.
- 619 Pillow Blocks.* Series P2-300 heavy-duty, ball-bearing units. Folder 2951, 4 pp. Link-Belt Co.

Assembly Components

- 513 Precision Springs. 16 pp. Timms Spring Co.

- 518 Self-Aligning Lock Nut. 6 pp. Standard Pressed Steel Co.
- 523 Sealing Washer. 1 p. Bartite Products Div., L. J. Barwood Mfg. Co. Inc.
- 525 Wheels and Casters. 2 pp. Saginaw Products Corp.
- 543 Machine Mounts. 4 pp. Clark-Cutler-McDermott Co.
- 620 Medium-Duty Casters.* Two units, one swivel and one rigid, are covered. 4 pp. Payson-Harris & Reed Inc.
- 621 Wire Markers.* Kilp-Marks, vinyl tubes, are available in two sizes. Bulletin S-401, 2 pp. Stahl Brothers Inc.

Manufacturing Processes, Parts

- 510 Centrifugal Castings. 16 pp. Janney Cylinder Co.
- 539 Vacuum Metallizing. 4 pp. Bee Chemical Co.
- 622 Hot-Dip Galvanized Products.* Product design and assembly in relation to hot-dip galvanizing; properties; corrosion resistance. 32 pp. American Hot-Dip Galvanizers Association Inc.
- 623 Stainless Machining Chart.* Table of recommended machining rates for 37 different types of stainless steel. Chart Sec. A, No. 5, 2 pp. Peter A. Frasse & Co.

Materials

- 501 Epoxy Pellet Adhesives. 4 pp. Epoxy Products Inc., Div., Joseph Waldman & Sons.
- 503 Thermocouple Material. 8 pp. Tempron Inc.
- 505 Designing with Steel. 60 pp. U. S. Steel Corp.
- 509 Bearing Material. 2 pp. Thomson Industries Inc.
- 516 Electrical Insulation Silicones. 8 pp. Silicone Products Dept., General Electric Co.
- 520 Beryllium-Copper Strip. 4 pp. Brush Beryllium Co.
- 528 Coated Strip Steels. 12 pp. Sharon Steel Corp.
- 533 Copper-Clad Laminates. 8 pp. Micarta Div., Westinghouse Electric Corp.
- 536 Asbestos Parts. 28 pp. Johns-Manville Co.
- 541 Vulcanized Fiber. 6 pp. Wilmington Fibre Specialty Co.
- 624 Neoprene Adhesive.* Technical data on SP-134 light-colored, heat-reactive phenolic resin for elastomer adhesives. 4 pp. Schenectady Varnish Co. Inc.
- 625 Industrial Felts.* Comparative properties of many industrial felts. 16 pp. Continental Felt Co.

Engineering Dept. Equipment

- 521 Direct-Recording Camera. 4 pp. Tektronix Inc.
- 537 Strain Gages. 4 pp. Kulite-Byrtex Corp.
- 540 Pointer-Indicator. 6 pp. Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp.

HELPFUL LITERATURE (Cont.)

- 626 **Properties of Cast Irons.*** Lists specifications of about 40 irons and alloys. 6 pp. Hamilton Foundry Inc.
- 627 **Self-Sticking Tapes.*** For drafting, engineering, layouts, charts, reproductions. Catalog 810, 26 pp. ACS Tapes Inc.
- 628 **Decimal Equivalent Chart.*** Provides quick

conversion of Birmingham wire gages and fractions to decimals. Chart DC-2, 11 x 14 in. Ohio Seamless Tube Div., Copperweld Steel Co.

629 **Temperature Recording.*** Combination records temperatures from -320 to +2000 F. Booklet Form TR, 12 pp. Brush Instruments Div., Cleveland Corp.

Circle the item number for information on products advertised or described, literature offered, and copies of editorial articles.

NEW PARTS, MATERIALS, ENGINEERING EQUIPMENT

Electrical, Electronic

- 549 **Synchronous timer motor** is oil filled for silent operation. Lake City Inc.
- 554 **Rotary potentiometer** incorporates double-wiper system which doubles resolution. Potentiometer Div., Daystrom Inc.
- 556 **Printed-wiring boards** are completely etched; meet military specifications. Advanced Design Inc.
- 557 **Fractional-horsepower motors** from 1/150 to 1/3 hp. Ashland Electric Products Inc.
- 558 **Permanent magnet** has high resistance to demagnetization. Crucible Steel Co. of America.
- 559 **Panel instruments** in clear-plastic rectangular cases. Weston Instruments Div., Daystrom Inc.
- 563 **Circuit-board retainer** holds board under 3g shock load. Industrial Div., Birtcher Corp.
- 567 **Gear motors** have planetary gearing system offering ratios from 1.87:1 to 941:1. Globe Industries Inc.
- 569 **Low-power rectifiers** in ratings to 750 ma maximum forward current. Semiconductor Dept., Westinghouse Electric Corp.
- 571 **Miniature switch** is snap-action unit in flat case. Cherry Electrical Products Corp.
- 575 **Terminal bushings** in fluted and tubular types. Frenchtown Porcelain Co.
- 579 **Synchronous motor** has speed of 8000 rpm with 400 cps input. Kollsman Motor Corp.
- 582 **Lamp adapter** for T-1 ultraminiature incandescent lamps. Industrial Electronic Engineers Inc.
- 584 **Recycling timer** has interchangeable timing elements. Industrial Timer Corp.
- 589 **Subminiature indicator lights** mount in 15/32-in. clearance hole. Dialight Corp.

Hydraulic, Pneumatic

- 547 **Hydraulic power unit** delivers 2½ gpm at pressures to 400 psi. Hein-Werner Corp.
- 548 **Bar-stock valves** for ¼ and ½-in. tube and pipe connections. Whitney Research Tool Co.

- 561 **Quick-connect couplings** for heavy-duty industrial uses provide maximum freedom of flow. Jack & Heintz Div., Siepler Corp.
- 562 **Dry lubricant** is insoluble in known organic solvents and water. Drilube Co.
- 564 **Welded diaphragm seals** for use in pressure instruments. Mansfield & Green Inc.
- 566 **Polyethylene tubing** is unaffected by most chemicals. Synflex Products Div., Samuel Moore & Co.
- 568 **Plugs and caps** for fittings and tube ends ¼ to 2 in. OD. Lenz Co.
- 570 **Packless valves** are globe-type units in ½ to 2-in. sizes. Harmonic Drive Div., United Shoe Machinery Corp.
- 574 **Air cylinder** for 250 psi air service has nylon and Delrin bearings. Alkon Products Corp.
- 577 **Flow-rate controller** has flow capacities from 0.01 gph to 12 gpm water. Brooks Instrument Co. Inc.
- 578 **Wire-reinforced vinyl hose** in ¾ to 12 in. OD sizes. Hungerford Plastics Corp.
- 580 **Solenoid valves** for cryogenic gases and liquids. Automatic Switch Co.
- 583 **Miniature shuttle valve** for use in multiple fluid-power circuitry. Clippard Instrument Laboratory Inc.
- 587 **Motor-driven pumps** in 13 sizes with ratings from 1/3 to 2 hp. Moyno Pump Div., Robbins & Myers Inc.

Mechanical Equipment

- 550 **Semiprecision bearings** handle radial and thrust loads. Kendale Washer & Stamping Co.
- 553 **Plain journal bushings** are capable of dynamic loads to 25,000 psi. Southwest Products Co.
- 565 **Shear-pin sprockets** protect against destructive overloads. Chain Belt Co.
- 573 **Brakes and clutches** are clutch-neutral units in sizes 6 and 8. Guidance Controls Corp.
- 576 **Self-lubricating chains** are available in 1-in. pitch. Whitney Chain Co.
- 585 **Disc brake** eliminates or minimizes alignment problems. Stearns Electric Corp.

588 **Pillow blocks** in ½ to 4-in. shaft sizes. Link-Belt Co.

Assembly Components

- 546 **Mounting screws** eliminate the need for countersinking. Shakeproof Div., Illinois Tool Works.
- 560 **Detent pins** in ¼ to 1-in. diam. Avdel Inc.

Materials

- 551 **Epoxy adhesive** cures in 1 minute at room temperature. Allco Products.
- 552 **Piezoid ceramic material** for transducer applications. Centralab Div., Globe-Union Inc.
- 555 **Stainless-steel strip** has highly reflective finish on both sides. Universal-Cyclops Steel Corp.
- 572 **Low-alloy steel** has 70,000 psi minimum tensile strength. Jones & Laughlin Steel Corp.
- 581 **Polyurethane foams** have open-pore structure in wide range of sizes. Foam Div., Scott Paper Co.
- 586 **Beryllium-copper strip** has tensile strength to 190,000 psi. Brush Beryllium Co.

Engineering Dept. Equipment

- 590 **Light magnifiers** provide shadowfree light and undistorted magnification. Safety Dept., Boyer-Campbell Co.
- 591 **Tape recorder** has speeds of 1.875, 3.75, 7.5, and 15 ips. Aero Data Corp., Div., American Concertone Inc.
- 592 **Temperature probe** for use in temperatures to 500 F. United Sensor & Control Corp.
- 593 **Steel filing cabinet** accommodates 1650 drawings to 24 x 36 in. Dancer Stikfile Co.
- 594 **Table whiteprinters** in two models are available for engineering drawings. Paragon-Revolute Div., Charles Bruning Co. Inc.
- 595 **Temperature chamber** for temperatures from -100 to +500 F. Delto Design Inc.

EDITORIAL ARTICLES

Single copies of the following articles are available as long as the supply lasts. Starred items are from previous issues. See Page 250 for other available reprints. Editorial content of MACHINE DESIGN is indexed in the Applied Science Technology Index and the Engineering Index, both available in libraries. Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.

- 15-1 **Instant Information.** Machine searching of literature may bring order to a world-size filing problem. (3 pp.)
- 15-2 **Pricing New Products.** Tying together the design of a product and its final cost. (5 pp.)
- 15-3 **Chemical Cleaning of Metal Parts.** Selection considerations; descriptions of chemical metal-cleaning processes. (8 pp.)
- 15-4 **Ball-Bearing Splines.** Matching splines to torque, radial-load, and life requirements. (3 pp.)
- 15-5 **DC Motor Control—Part 1.** Motor funda-

- mentals affecting the choice of control devices. (6 pp.)
- 15-6 **Edge-Lighted Panels.** Techniques of design and selection of materials for edge-lighted panels and dials. (2 pp.)
- 15-7 **Flexible-Beam Suspensions—Part 2.** Solving flexible-beam suspension problems to ensure safe vibration characteristics. (9 pp.)
- 15-8 **Cam-Operated Mechanisms.** Nondimensional graphs simplify calculations of velocity, distance, time. (3 pp.)
- 15-9 **Packaging Semiconductor Networks (Abstract).** Factors to consider in equipment design; technique for use in high-density systems. (3 pp.)
- 14-3 **New Roller-Chain Horsepower Ratings.*** Getting the most out of the new horsepower and speed ratings proposed by chain manufacturers. (4 pp.)
- 14-4 **Preventing Electronic Hot Spots.*** Component layout and assembly techniques. (4 pp.)
- 14-5 **Flexible-Beam Suspensions—Part 1.*** How to design a suspension with safe vibration characteristics. (9 pp.)
- 14-8 **Stepped Shafts and Nonuniform Beams.*** Predicting deflections at any point in a stepped shaft or variable-section beam. (6 pp.)
- 13-2 **How To Sell Ideas.*** Presenting ideas to management; what sales resistance to expect. (5 pp.)

- 13-3 **High-Pressure Hydraulics.*** Design, safety, cost factors involved in designing or specifying a high-pressure hydraulic system. (7 pp.)
- 13-4 **Reverted Gear Trains.*** Determining the number of teeth needed to get exact ratios in a reverted gear train. (4 pp.)
- 12-4 **Clearance in Rolling Bearings.*** Calculation of probable bearing life for any amount of diametral clearance or preload. (5 pp.)
- 12-9 **Least-Squares Lines.*** Techniques for assessing the statistical significance of a line drawn through a series of scattered data points. (8 pp.)
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- 9-6 **Chemically Milled Structures.*** Advantages and disadvantages of chemical milling; design of chemically milled parts. (9 pp.)
- 9-7 **High-Reduction Hypoids.*** Types and applications; design of sets for ratios from 10:1 to 120:1. (9 pp.)

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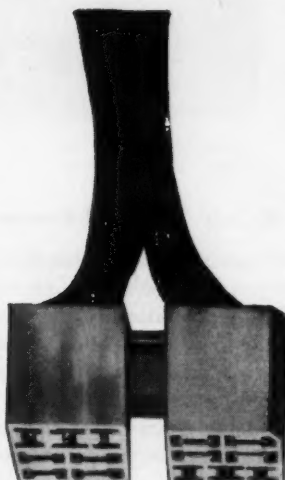
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This **AMPin-cert***

connector
line

GIVES YOU BOTH

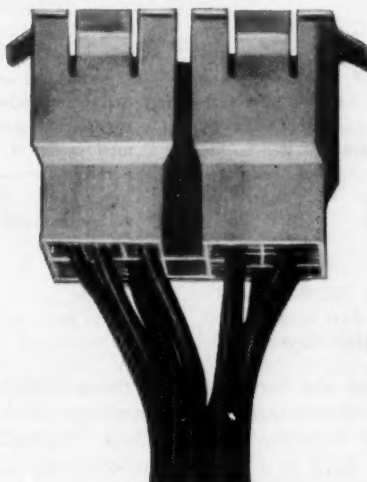
economical assembly,
easy maintenance

WITH ALL 3



AMP-LOK®

- self-locking friction contacts create positive wiping action
- low millivolt drop
- 3, 4, 6, 9 and 12 circuits
- wire ranges #22-#18, #20-#15 and #18-#16 AWG
- nylon housing has "snap-in" wings for through panel use
- keying plug prevents mismatching caps in side-by-side mounting



AMPEEZ*

- 7, 14 and 20 circuit
- insertion/extraction force of 2-5 lbs. per contact
- "Tab-Gap Lok" prevents contact spread
- fits wire size range #18-#14 AWG
- amperage rating 20-25
- nylon housing polarized for perfect mating
- mounts flush—only .125" projects from panel front



FASTIN-FASTON*

- 1, 2, 6 and 8 circuits
- contacts are self-locking in housing
- fully tested for millivolt drop
- nylon or cycloc housings polarized to prevent circuit errors
- wire insulation support for vibration resistance
- full wire size #18-#14 AWG

* Trademark

This line of AMPin-cert Connectors gives you minimum insertion and withdrawal forces, maximum amperage ratings, resistance to vibration, corrosion and environmental factors . . . everything to assure lower assembly costs, rugged performance and simplified maintenance. Check these features and see how they fit your design plans. Any additional information you may need will be sent on request.

AMP INCORPORATED
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Patent Office May Go 'Dutch' To Speed Processing

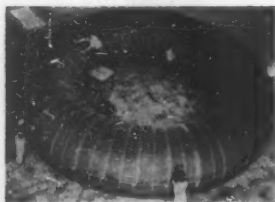


A backlog of 196,000 applications for patents has faced the Patent Office for more than a year, a situation aggravated by increasingly complicated inventions and high turnover of examiners. Discussing the problems before the Patents Committee of NAM, newly appointed Patent Commissioner David L. Ladd outlined a revolutionary plan being adopted in the Netherlands. Applications for patents will be published at a certain interval after being filed, under the Dutch plan, but there will be no further steps toward issuing a patent except where necessary. Either the patentee or a "member of the public" can call the case up for prosecution. At the end of seven years, if there has been no prosecution and issuing of the patent, the application is abandoned.

MARITIME ENGINEERING SCIENCE, a new course for naval architecture and marine engineering students who intend to concentrate on research and development work, is offered by the University of Michigan. Mathematics will be stressed, and technical electives will include operations research, control systems, instrumentation, nuclear engineering, and digital and analog computer application.

MAJOR CHANGES IN CURRICULUM are advocated by the majority of civil engineering educators, according to a recent survey by the American Society of Civil Engineers. A pre-engineering program and an extension of the total period of education is favored. ASCE reports an "overwhelming sentiment" for promoting graduate study and for establishing graduate professional schools of engineering.

Doughnuts in the Sky



Present knowledge and hardware could put a doughnut-shaped manned space station in orbit in three years, according to Robert W. Richardson, vice president of Goodyear Aircraft Corp. An inflatable fabric space station could be built in a year and present boosters could put it into orbit, but it may take three years to make existing rockets safe enough to send up astronauts, according to Mr. Richardson. Goodyear is building a 24-ft doughnut for testing by NASA and a 30-ft model for its own research.

Rigid-Rotor Helicopter Cuts Cost, Training

Lockheed Aircraft Corp., under Army and Navy sponsorship, has developed a radical helicopter with fixed-pitch rotor blades. Directional control is effected by changing the angle at the gimbal where the rotor shaft is mounted on the fuselage, and lift is controlled by varying engine speed. The simple design should not only reduce cost to about half that of a conventional helicopter, but should permit operation by relatively inexperienced pilots.

FROZEN WATER (i.e., old-fashioned ice) may be used to preserve space travelers' food. General Electric Co. learned that ice is as good as thermoelectric refrigeration—for trips of 20 man-days or less. Kept under pressure of 0.02 psi, it sublimates to vapor with heat absorption capability of 1220 Btu per lb.

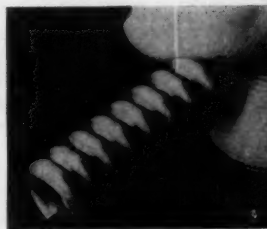
FLIGHTLINE RADAR CHECK for F-105 tests all modes — air-to-air, air-to-ground, terrain avoidance, etc.—with a single piece of equipment developed by Remanco Inc., Santa Monica, Calif., for Republic Aviation Corp. Previously a checkout took 24 hours, and the plane had to be moved to test equipment for each mode.

Quick Test for Corrosion Resistance

Anodized aluminum automobile trim coming off a production line can be checked to see if it will provide optimum corrosion resistance with a new test developed by Ford Motor Co. In the FACT (Ford Anodized Aluminum Corrosion Test) system, a small electrolytic cell containing a corrosive agent is placed in contact with the surface of the part. Subsequent resistance to a mild electric current is measured during a three-minute period in which corrosion of the coating is accelerated and insulating effectiveness is determined. The test has been correlated with actual corrosion on 2000 samples exposed to winter weather. All suppliers of Ford trim will use the test.

High-Strength Stainless Spring Wire

Stainless steel spring wire having tensile strength far higher than music wire is announced by National-Standard Co. In laboratory tests of 0.075-in. material, tensile strength of the new NS-355 was 100,000 psi higher than for music wire. Guaranteed minimum tensile strength of 0.195-in. NS-355 is 290,000 psi, compared to 245,000 psi for music wire. Modulus of elasticity ranges from 29,300,000 at 80 F to 24,600,000 psi at 800 F. Wire is suitable for compression and extension springs.



PLASTIC SPARK PLUGS performed well in a three-hour road test during which mean running temperature was 450 to 500 C, maximum temperature at flash point was 3000 to 3500 C, head pressure was 700 to 800 psi, and voltage at spark was 15,000 to 18,000 v. The plugs were molded by CIBA (A.R.L. Ltd.), Duxford, Cambridge, England, from powder supplied by Anglo-American Vulcanized Fibre Co.

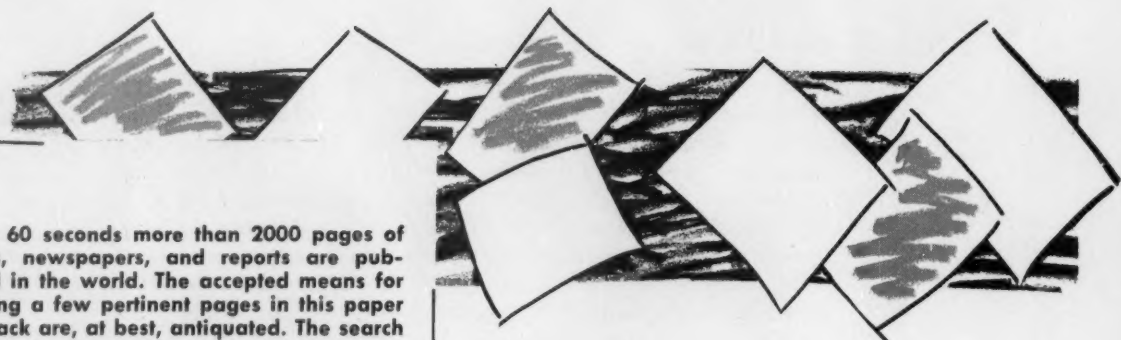
OVER 99.99 PER CENT PURITY is attained in gold deposits with a new electroplating process developed by Sel-Rex Corp., Nutley, N. J. The Temperex HD process is said to meet or surpass the most exacting finishing specifications of manufacturers of transistors and other electronic components. Hardness is 75 Knoop, ductility is "remarkable," and there is no practical limit of thickness.

Thermocouple Gains Precision with Matched Materials

A "revolutionary" thermocouple, fabricated with a body of the same material as the wall of the test vehicle under study, eliminates errors due to difference in thermal properties at the point of measurement. Designated Model P by the developer, Nanmac Corp., Indian Head, Md., the thermocouple has been fabricated from Plexiglass, teflon, asbestos phenolic, micarta, graphite, copper, molybdenum, and tungsten. Thermal elements are flat ribbon wires, insulated by thin sheets of mica. Response time is less than one 10 millionth sec to transient flow; temperature range is -320 to over 5000 F.

CONDUCTIVE PLASTIC has "very nearly ideal" properties for conducting electricity, according to Mesa Plastics Co., Los Angeles. Applications of the new material include waveguides, RF connectors, and electronic components; it was found to be well adapted to production of printed circuits requiring a flush surface.

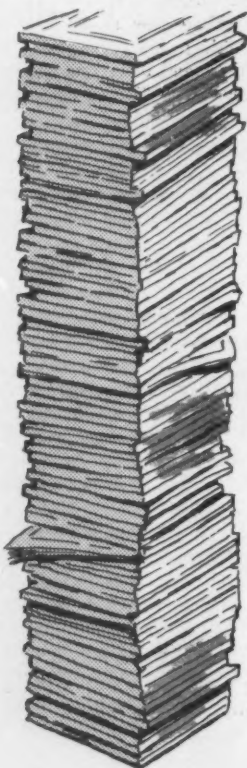
NEW PROPERTIES of pyrolytic graphite, including the ability to polarize infrared light, were recently discovered by the Metallurgical Products Dept. of General Electric Co. GE also announced that the material, first used as a coating, is now commercially available in plates, cylinders, and special shapes up to 4½ ft long.



Every 60 seconds more than 2000 pages of books, newspapers, and reports are published in the world. The accepted means for locating a few pertinent pages in this paper haystack are, at best, antiquated. The search problem is particularly acute in science and engineering. As one observer notes: "We are in danger of redesigning the wheel about six times a week." Put in more practical context by a leading steel-company executive: "It is cheaper to repeat an experiment if the cost does not exceed \$100,000 than to pay for a search to determine whether it has been done before." Government, industry, and privately endowed organizations are now actively working on "information retrieval," and while no pat answers have resulted, several approaches, based on the use of computers, may eventually bring order to a world-size filing problem.

**For the big filing problem,
mechanized searching by
computer provides . . .**

Instant



ENGINEERS and scientists who need reference material to ensure that they make a reasonable number of well-informed decisions have resorted to three methods for obtaining information:

- They have tried to be selective in their reading, relying on judgment to select the "one page in a million" with the highest probability of containing information of potential interest.
- They have tried to rely on abstracting and indexing services that compress the information that must be scanned.
- They have tried to develop information files that serve the special needs of individuals or organizations.

These methods of coping with the growing pile of world literature have their limitations:

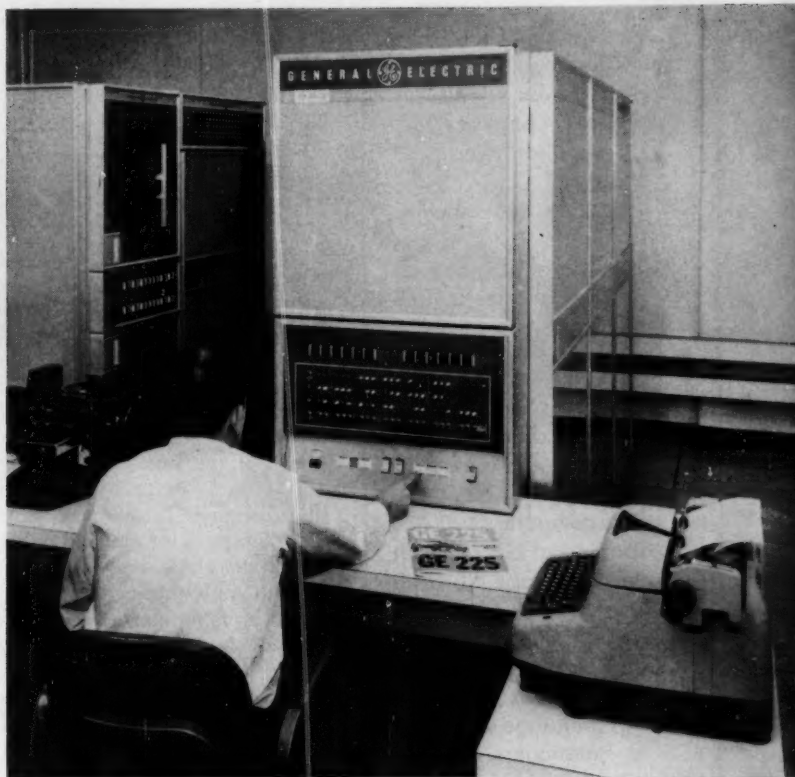
- Scientists who try to read selectively find themselves losing more and more material because it's scattered through many publications.

If they attempt to make their reading general, they lose some of the gems that the reviewers of their field have found inappropriate for inclusion in general discussions. The reviewers must also cut corners to get the job done.

- Those who rely on abstracting and indexing services find they face two problems: First, these services have proliferated tremendously. In a survey conducted two years ago, it was found that more than 300 are used by various companies in an attempt to keep up with the literature of their field. Second, the coverage is far from complete, and it is difficult to decide which ones give reasonably complete coverage of a particular field. In chemistry, for example, where the American Chemical Society prides itself in relatively complete coverage, 130,000 abstracts will be prepared this year—which involves no mean task in order merely to scan the results.



Information



• For those who attempt to develop special information files for their own use, it is usually necessary to sacrifice completeness of coverage because of the potential scatter of pertinent information in a tremendous number of publications. The usual budget limitation for this type of work, in all but the largest organizations, is also an important factor.

In a questionnaire answered by 604 organizations, Western Reserve University found that 37 per cent of the responding companies prepare abstracts of published papers on a regular basis. It was also found that companies engaging in abstracting and indexing of published literature incurred these annual expenses:

- 40 per cent—more than \$ 5000
- 28 per cent—more than \$10,000
- 20 per cent—more than \$15,000
- 7 per cent—more than \$35,000

And then, of course, there are companies that solve the informa-

tion problem by ignoring it. A large steel company, for example, insists that it is cheaper to repeat an experiment if the cost does not exceed \$100,000 than to pay for a search to determine whether it has been done before.

Why is it so difficult to find information, even when it has been indexed consistently and in detail? There are two reasons:

- The economic impossibility of processing, for later retrieval, the majority of literature of probable pertinent interest.
- The breakdown of traditional library tools in coping effectively with the detailed requirements of individuals in identifying information pertinent to a given problem.

Consider a question from a jet-engine manufacturer: He wants to find a high-temperature metal that possesses the optimum combination of fabricating properties. The inquiry asks for all literature on "the form-

ability of the sheet form of as many of the high-temperature alloys as have been tested." None of the known indexes can handle this type of question adequately. However, there are so many problems of this sort that are of extreme importance to the American economy and defense effort that there has been a strong reaction in this country aimed at providing specialized information centers. All of these centers process large segments of the literature and much of their efforts overlap. Here are some of them, with estimated yearly budgets:

- The Titanium Information Center—\$1 million
- Defense Metals Information Center—\$1 million
- Infrared Information Agency—\$1 million
- Solid Propellant Information Agency—\$150,000
- Prevention of Deterioration Center—\$150,000

Input:

1. Acquisition of literature in a subject field
2. Analysis by scientists
3. Digests: English language and "telegraphic"
4. Encoding into machine language
5. Storage of encoded digests in magnetic-tape library

Output:

6. Questions from clients
7. Analysis and programming of questions; storage in memory of GE 225 computer
8. Loading of GE 225 with magnetic tape library
9. Mechanized search
10. Identification of pertinent information
11. Transmission of English-language abstracts to questioners.

Electronic Component Information Center—\$250,000

Chemical-Biological Co-ordination Center—\$150,000

Cobalt Information Center—\$75,000

To these can be added the normal indexing and abstracting services that are provided by the various technical societies, such as Chemical Abstracts, Mathematic Abstracts, Review of Metal Literature, Engineering Index, etc.

One apparently ideal solution to the problem is the strong centralized processing system of the USSR., which receives, in one spot, the cream of the world's published scientific and technical information and prepares 13 abstract journals and 48 express information bulletins. The system criss-crosses 500,000 important published papers and involves a minimum of overlap and confusion.

The Russian system—which undoubtedly has economic advantages—is not practical or desirable for this country, according to some experts. Prof. Allen Kent, associate director of Western Reserve Uni-

versity's documentation center, feels that "we are too far along on our own way." In his opinion, "the only reasonable course is the creation of a new type of 'library'—a library of encoded information, prepared by the various professional associations, but available for searching, duplication, and distribution anywhere by machine methods, so that centralized *exploitation* as distinguished from centralized *processing* of scientific information can take place. Many separately staffed abstracting services for processing and libraries for exploitation will operate; but there should be co-ordination on a national scale of processing methods and coverage."

Kent and his associates at WRU have developed methods for the analysis, encoding, and machine searching of literature so that professionals may be kept currently and continuously informed of everything published in their particular fields. This program has led to an operational literature-searching service for the American Society for Metals. It will also lead to the similar programs for other organizations.

1—Question: "Any and all technical data on recent improvements in die casting."

2—Processing: Question is coded to Semantic Factor Code of words to be searched:

A=C-NS {
B=1025 } Casting

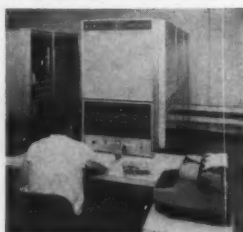
C=M-TL {
D=P-SS } Die Casting
E=3001 }

F=M-CH {
G=M-CL } Die
H=2009 }

Question is put into logical structure for searching: (A·B·C·D·E) + (A·B) (F·G·H). This reads (A and B and C and D and E) or (A and B) and (F and G and H).

Cards are key-punched with above and fed into the machine.

Western Reserve's answer to information storage and retrieval centers around the General Electric 225 computer. The machine can plow through 100,000 technical articles per hour; searches one year's output of metallurgical literature in a few hours. System is a co-operative venture sponsored by American Society for Metals, and provides subscribers with three types of service: Current-awareness searches conducted at two-week intervals; bibliographic searches which will soon cover a time span of 10 years; preparation of encoded tapes for companies having their own machine searching facilities. Typical English-language abstract (below), prepared by team of 50 qualified abstracters, is mailed to subscriber who can then ask for photo-copy of entire article. WRU will soon furnish overnight service.

3—Retrieval

4—

ABSTRACT 138-E. Sound Waves Improve Diecasting Quality. John W. Weber and Earle W. Rearwin. Foundry, v. 89, Feb. 1961, p. 69-71.

Application of ultrasonic and sonic wave length energy during diecasting to improve structure, mechanical properties and surface finish and to reduce rejects. (E13, 1-74)

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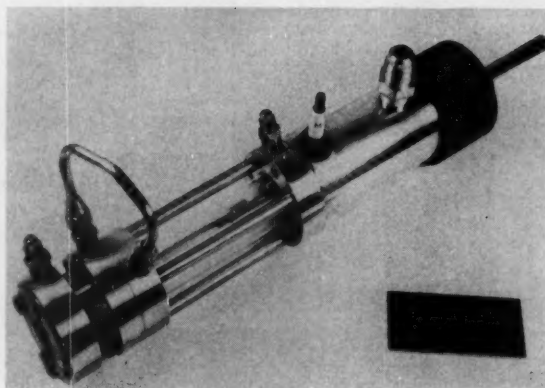
Electricity Boosts Gas-Burner Output

CAMBRIDGE, MASS.—A new type of burner consumes both gas and electricity to produce flame cores that are hot enough to melt tantalum (5410 F). And since the device "burns" readily available fuels (natural gas at normal line pressures, 60-cycle current) in air atmospheres, expensive compressors, rectifiers, etc., are eliminated and oxygen equipment is not needed. Patented by Combustion and Explosives Research Inc., the burner has been further developed by Arthur D. Little Inc.

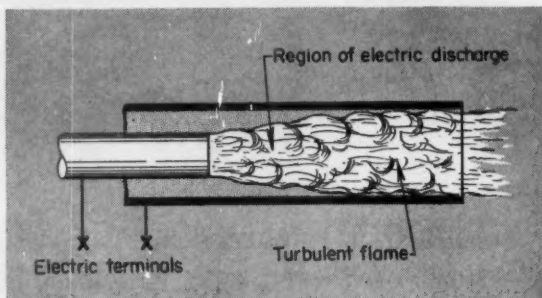
Gas and air are premixed and the flame ignited at the port. Then ac energy is added to increase flame temperatures to 6000 F. To be efficiently heated, the flame must be turbulent—if not, a high-current arc is set up, rather than the generally dispersed discharge that is desired. At the start of discharge, the impressed electrical energy (2000 v, 5 amp is typical) produces weak current between electrodes. More current flows as gas temperatures get higher, and finally, a critical conductivity is reached where total breakdown of the flame occurs and the electrical discharge becomes steady.

Tests with the burner consuming only fuel gas show that, with an input of 32,000 Btu per hr, average gas-flow temperature reaches 3380 F. When the electrical input of 4.6 kw (15,700 Btu per hr) is added, the average flow temperature climbs to 4440 F, and the flame core approaches 6000 F.

Almost all hydrocarbon gases make suitable fuels for the burner. When combustion flames have insufficient thermal ionization to initiate discharge, a small amount of ionizing salts can be added.



Even liquid or powdered fuels can be burned in the new burner, although the combustion chamber would require redesign. For highest temperatures, oxygen replaces air.



Army Honors Davy Crockett Developers



Research and development work on nuclear battlefield weapons (including the Davy Crockett weapons system, left) has won \$25,000 worth of recognition for three Picatinny-Arsenal scientists. The cash award, largest that can be made under the Government Employee Incentive Act of 1954, was shared by Robert M. Schwartz, Milton E. Epton, and the widow of the late Irving Mayer.

Nuclear achievements of the three-man team began in 1953, when they developed the first atomic artillery shell for the 280-mm gun. Since then they have concentrated on atomic weapons that are small enough to be used by



infantry troops. Culmination of their imaginative efforts was the Davy Crockett, a battlefield weapon which gives the foot soldier an atomic capability.

Ideas conceived by the trio have also resulted in extremely safe and reliable nuclear weapons in the missile field, including atomic adaption kits for Honest John and Jupiter missiles. The kits revolutionized assembly and test procedures for warhead sections, and the operation now takes minutes instead of hours. The adaption-kit concept also permits the use of unclassified training aids by U.S. allies using weapons with nuclear capacity.

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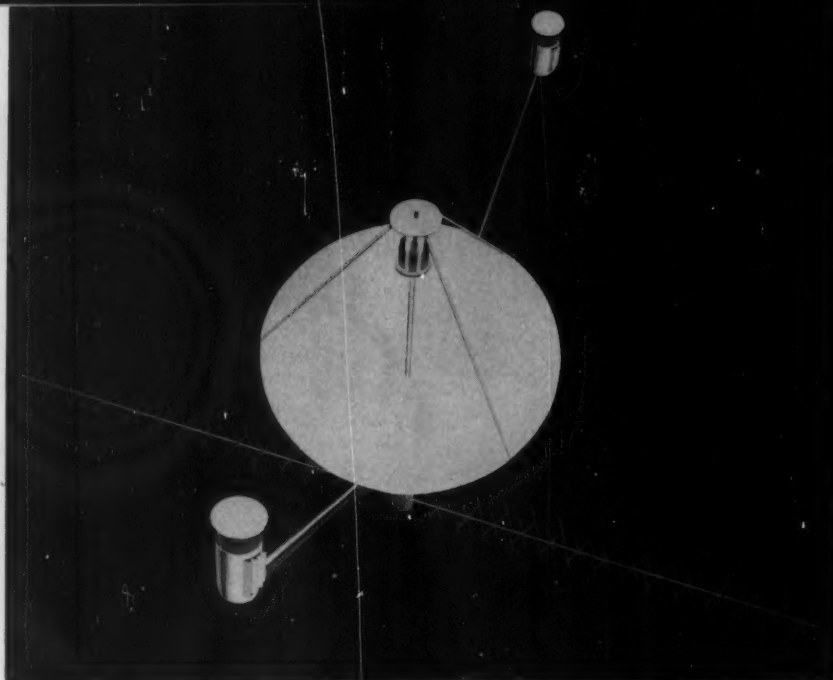
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Kitchener, Ontario.



Conditions near the sun could be discovered by equipment in a solar probe proposed by D. H. Dickstein, Missile and Space Vehicle Dept., General Electric Co. Mr. Dickstein suggests that the interaction between magnetic fields and charged particles could be studied, as well as a variety of other conditions. A Saturn rocket configuration scheduled for use about 1965 could place the 250-lb probe in an elliptical orbit that would take it within 9 million miles of the sun. Plans call for conversion of solar energy to electrical power in the probe. Pods at the end of the booms contain telemetry equipment, the initial stabilization system, power converters and instruments to gather data. The long antenna is aimed toward the earth at all times.



ENGINEERING NEWS

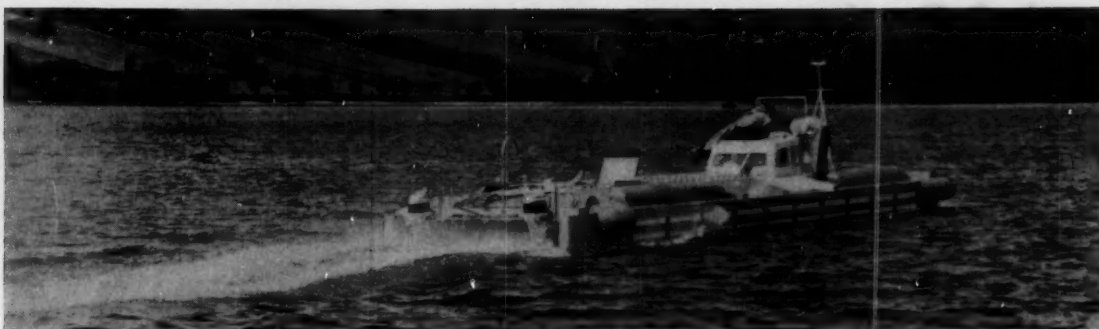
PICTURE REPORT



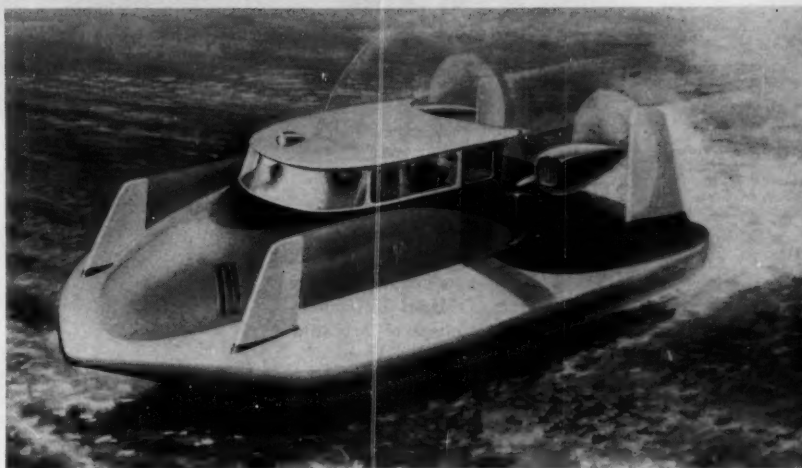
It won't fly, but this silver-circuit-printed piece of Koroseal will bring in all television channels and FM stations. Called the "Cat's Whiskers," it is designed to replace rabbit-ear antennas. RF Industries Inc., Summit, N. J., points out that its new antenna can be tacked up almost anywhere—in the attic, behind drapes, on the back of a chair, or under a rug.



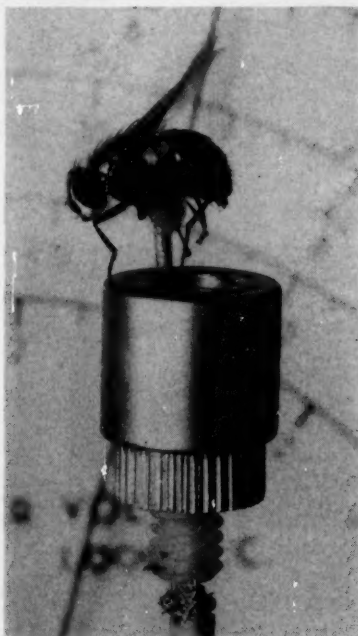
Weapon-carrying drone helicopter will serve aboard a destroyer. Both are part of Navy's weapon system DASH (Drone Anti-Submarine Helicopter). The helicopter can fly to an area where sonar has detected a sub, hover until instructed to drop its homing torpedoes, then return to its destroyer. The DSN-1, a coaxial-rotor helicopter built by Gyrodyne Co. of America Inc., is a prototype powered by a 72-hp engine. Production models will have more powerful Boeing turbine engines.



Air-cushion vehicles are being turned out at a great rate in Great Britain. The artist's conception (right) shows a 24-passenger launch which will go 70 mph over water, mud flats, or flat ground. This vehicle, built by Vickers Ltd., is scheduled for completion in December. A craft built and now under test by William Denny & Bros. Ltd. (above) is for use as a river ferry. Unlike fully airborne GEV, this one has side-walls which touch the water. Consequently, less power is required to maintain the air cushion. Top speed of the Denny craft is expected to be 35 knots.



Flutter of a fly's wings increases air pressure enough to be detected by Variducer, a highly accurate variable piezoelectric transducer made by Mirax Chemical Products Corp., St. Louis. Mounting of the Variducer eliminates over 85 per cent of noise normally produced by transducers, and its variability feature permits prestressing of the crystal to the level desired, before or after installation.



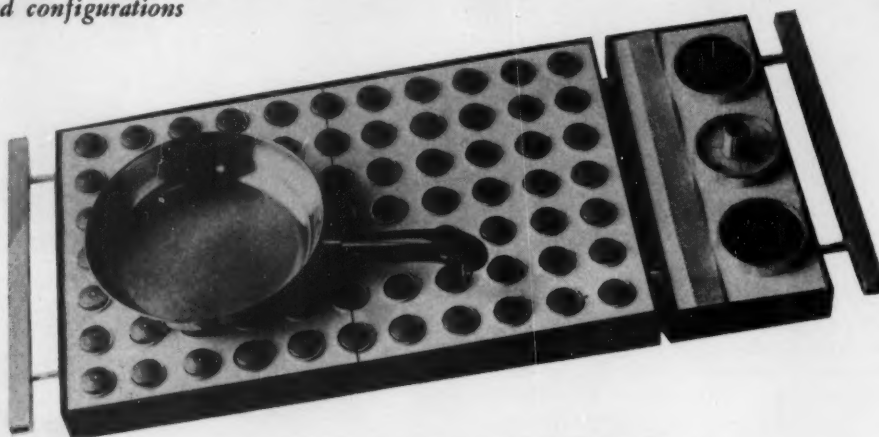
Mobile mechanical man

performs dangerous jobs necessary in rocket-engine research at the Elkton, Md., division of Thiokol Chemical Corp. Guided by electronic remote controls, it transports experimental engines and propellant compounds from the laboratory to the testing area, and it can set up a test engine for static firing. Thiokol feels that—judged by the image created in science fiction—its robot is not very handsome. It has only one arm, no head, and just one huge foot. However, the hand can turn continuously in either direction, the fingers have a firm and untiring grip, the telescoping body can reach to 10 ft, and the robot can travel at the rate of 2 mph—pretty good for a 400-pounder.



Industrial Design

comments and configurations



1.

Range with multiple Calrod units heats only where a pan makes contact (1). Designed by Duncan Peek, Philadelphia Museum College of Art, it is one of six Alcoa Student Design Merit Award winners. Proper contact is also of utmost importance in the aluminum and rubber chair (2) designed by Stephen Kimmell, Institute of Design, Illinois Institute of Technology.

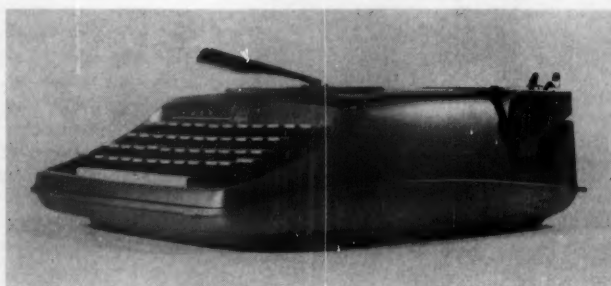
Molded Cyclac base of Capri typewriter (3) is half of the carrying case. It won the Design Award of the Institute of Industrial Designers for Sundberg-Ferar, is made by Remington Rand for Sears, Roebuck & Co.

Adjustable in height from 30 to 46 in., D-H Associates' Planofix drawing table (4) also tilts from horizontal to vertical. An international jury in Brussels awarded it a gold medal.

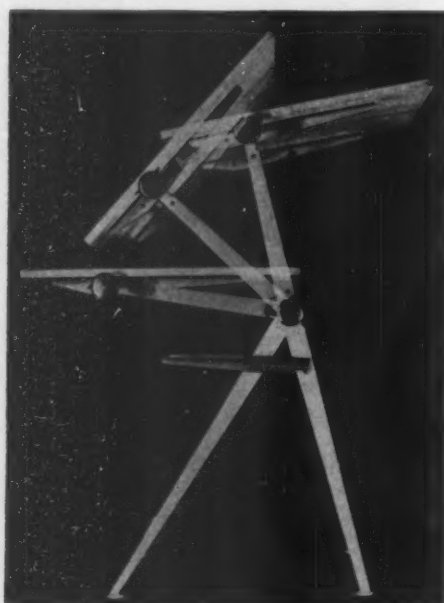
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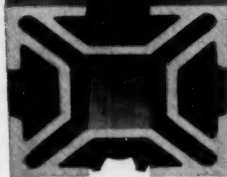


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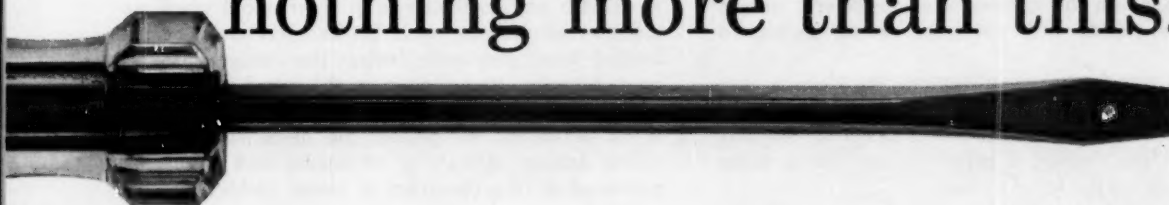


4.





Because of this extrusion, engineered with Olin Aluminum, 15 floors of the TIME-LIFE building in New York City can be quickly re-shaped with nothing more than this:

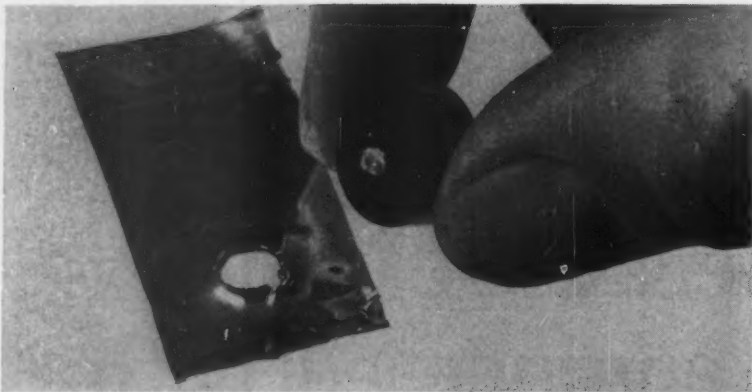


Olin engineers helped design this unique extrusion to serve as the universal junction of movable wall panels. The genius of this extrusion makes it possible to change office size, shape and color in jig time with nothing more than a screw-driver! So many Olin ideas like this have saved so much time and money for fabricators, design-

ers and architects that modesty forbids telling all. As versatile as aluminum is, it doesn't think, doesn't create designs, or doesn't fabricate itself. That's why Olin Aluminum offers you the services of its marketing and technical staff. They "think aluminum." Don't you think it would be a good idea to call Olin?

Olin
ALUMINUM

400 PARK AVE., NEW YORK 22, NEW YORK



Single drop of water, shot as a jet from a compressed-air gun, easily penetrates thin pieces of aluminum and puts a sizeable dent in samples of steel. Water bullets travel at speeds up to 3400 mph, generate flashes of light when they strike the target surface. Westinghouse scientists are using the high-speed particles to study water-drop erosion, which occurs on turbine blades and on the surfaces of missiles and aircraft.

3400-mph Water Bullets Provide Tip-Off to Turbine-Blade Erosion

PITTSBURGH—Research scientists at Westinghouse Electric Corp. are shooting "bullets" of water into solid blocks of steel. Traveling at velocities up to 3400 mph, water drops penetrate thin pieces of metal almost as easily as rifle bullets do.

Purpose of the experiments is to study the action of water droplets upon the rapidly spinning blades of a steam turbine. While steam condenses only where turbine blades are longest, these sections of the blade are traveling at close to supersonic speeds. Over a long period of time the drops erode leading edges. Similar erosion occurs on the surfaces of airplanes and missiles when they collide with raindrops during high-speed flight.

The Westinghouse experimenters are delving into this complex erosion process by firing small lead pellets at a water reservoir which is sealed except for one tiny opening. Upon impact, a pellet squeezes out a water jet which strikes the metal surface.

A flash of light is emitted for less than one-millionth of a second after the water strikes the metal. Theories



on why it forms have not yet been developed.

The jets of water create small craters in test specimens with profiles similar to those produced when meteorites crash into the earth. Uniform jets having smooth leading faces cause more damage than irregular-shaped ones; however, irregularities in the metal surface have little effect upon the erosion process. Thin films of water or oil do not protect the metal surfaces, and visible damage appears to correspond well to that experienced during operation of steam turbines. Stellite and tungsten carbide have shown the greatest resistance to the supersonic water bombardment.

Meetings and Shows

Aug. 14-17—

Society of Automotive Engineers Inc. National West Coast Meeting to be held at the Sheraton Hotel, Portland, Oreg. Additional information can be obtained from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Aug. 15-17—

Cryogenic Engineering Confer-

ence to be held at the University of Michigan. Additional information can be obtained from the university, Ann Arbor, Mich.

Aug. 22-25—

Western Electronic Show and Convention to be held at the Cow Palace, San Francisco. Additional information can be obtained from Wescon, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

Aug. 28-Sept. 1—

International Heat Transfer Con-

ference to be held at the University of Colorado, Boulder, Colo. Sponsors are American Society of Mechanical Engineers and American Institute of Chemical Engineers; also participating are American Society of Refrigerating and Air Conditioning Engineers, Chemical Institute of Canada, Engineering Institute of Canada, Institute of the Aerospace Sciences, Society of Automotive Engineers Inc., and the University of Colorado. Papers will be presented by engineers from 13 countries. Additional information can be obtained from ASME

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many
chairs



must
you
occupy?

Recently someone said that "the design engineer today is engaged in a game of musical chairs...without music." He must see his design not only from the chair of a designer but from that of top management, the sales department, service, purchasing, production...to say nothing of the customer! He must design for better profits, more selling advantages, simplified manufacture, efficient purchasing of components, and "better than competition."

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ENGINEERING NEWS

Meetings Dept. 29 W. 39th St., New York 18, N. Y.

Sept. 5-8—

Association for Computing Machinery. 16th National Conference and First International Data Processing Exhibit to be held at the Statler-Hilton Hotel, Los Angeles. Further information is available from Benjamin F. Handy Jr., Litton Systems, 5500 Canoga Ave., Woodland Hills, Calif.

Sept. 11-14—

Society of Automotive Engineers Inc. Heavy-Duty Vehicles Meeting, including production forum and engineering display, to be held at the Milwaukee Auditorium, Milwaukee. Further information can be obtained from SAE, 485 Lexington Ave., New York 17, N. Y.

Sept. 11-15—

Instrument Society of America. Sixteenth Annual Instrument-Automation Conference and Exhibit to be held at the Biltmore Hotel and Memorial Sports Arena, Los Angeles. Further information is available from Meetings Manager, ISA, Penn Sheraton Hotel, 530 William Penn Place, Pittsburgh 19, Pa.

Sept. 14-15—

American Society of Mechanical Engineers - American Institute of Electrical Engineers. Engineering Management Conference to be held at the Roosevelt Hotel, New York. Additional information can be obtained from ASME Meetings Dept., 29 W. 39th St., New York 18, N. Y.

Sept. 18-20—

Standards Engineers Society. Annual Meeting to be held at the Hotel Sherman, Chicago. Additional information is available from J. A. Caffiaux, executive secretary of SES, 11 W. 42nd St., New York 36, N. Y.

Sept. 24-27—

American Society of Mechanical Engineers. Petroleum Mechanical Engineering Conference to be held at the Muehlebach Hotel, Kansas City, Mo. Further information is available from ASME, 29 W. 39th St., New York 18, N. Y.

Sept. 25-28—

Association of Iron and Steel Engineers. National Convention to be held at the Penn-Sheraton Hotel, Pittsburgh. Further information can be obtained from society headquarters, 1010 Empire Bldg., Pittsburgh 22, Pa.

Oct. 5-8—

American Society of Industrial Designers. Annual Meeting to be held at the Ambassador Hotel (Oct. 5) and the St. Catherine Hotel (Oct. 6-8). Additional information can be obtained from Richard M. Wilkes & Associates, 521 N. La Cienega Blvd., Los Angeles 48, Calif.

Short Courses and Symposia

Aug. 13-18—

Seminar on Theoretical Aspects of Magnetohydrodynamics to be held at Pennsylvania State University. Purposes are to present basic principles of plasma dynamics; to introduce the basic macroscopic equations of magnetohydrodynamics; to study phenomena associated with wave motion, boundary layer flow, and plasma instabilities; and to present the fundamentals of plasma propulsion and power generation. Further information is available from the Conference Center, Pennsylvania State University, University Park, Pa.

Aug. 21—

Fifth Symposium of the Welded Electronic Packaging Association to be held at the Palo Alto, Calif., research facility of Lockheed's Missiles and Space Div. Topics will include encapsulants, coatings, and adhesives; metallurgy; advanced joining techniques; test inspection and quality control; welding techniques and manufacture; and reliability. Further information is available from Charles Antony, Lockheed Missiles and Space Div., Sunnyvale, Calif.

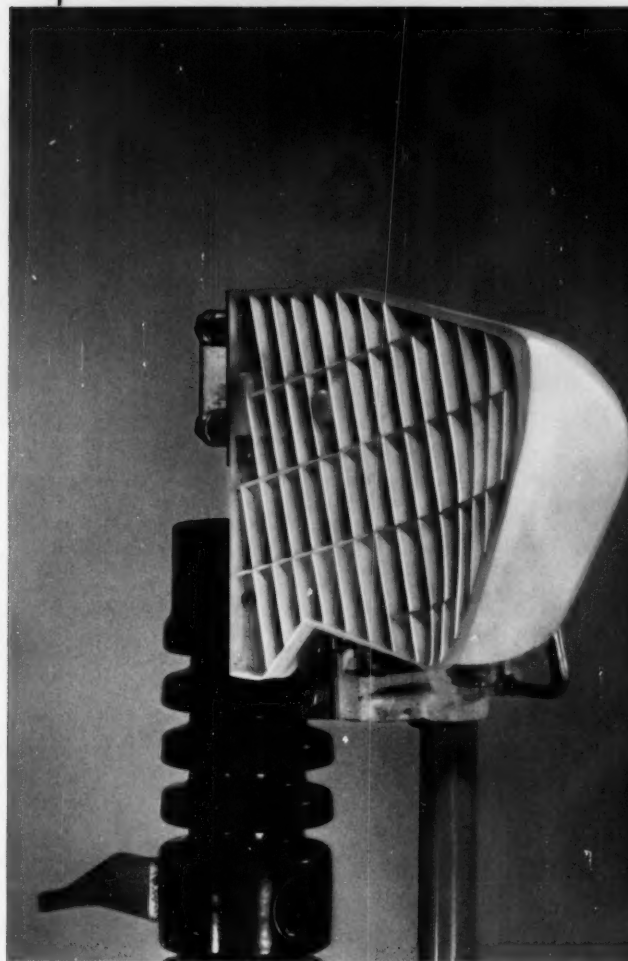
Aug. 21-25; Aug. 28-Sept. 1—

Strain Gage Lecture Course (first week) and Strain Gage Laboratory Course (second week) will encompass both theoretical and practical considerations. Topics in the lecture course include: Basic theory

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**Significant
advance in
load-break
design**



Arc Chute molded by Chicago Molded Products Corporation, Chicago, Ill., for Westinghouse Electric Corporation

made possible by using DELRIN® for arc chute

New electrical cutout device features a self-contained load-break, designed to permit repetitive interruptions of high load currents throughout its life without maintenance or replacement of parts (such as fuse links and gas bottles). The significant advance in design is made possible by the use of Du Pont's DELRIN acetal resin for the arc chute through which the contact blade is pulled. Load-break operation is achieved by lowering the knife switch between the facing grids of the chute away from the contact points. The normal arc is quickly extinguished (less than 0.1 second) by a de-ionizing gas generated inside the chute from the resulting arc heat.

The arc chute of DELRIN lasts the life of the cutout, is safe and reliable.

Units have been tested for 200 load-break operations at 200 amps, 15KV with a circuit power factor of 70% or higher. Inspection showed negligible wear, only very slight discoloration and no evidence of carbon tracking.

Only DELRIN offered the required combination of properties: high strength, stiffness and creep resistance; exceptional non-tracking and non-carbonizing characteristics; high resistance to erosion and abrasion; durability under outdoor exposure; toughness at low temperatures; good insulating characteristics unaffected by variations in moisture and temperature; and a non-adherent surface.

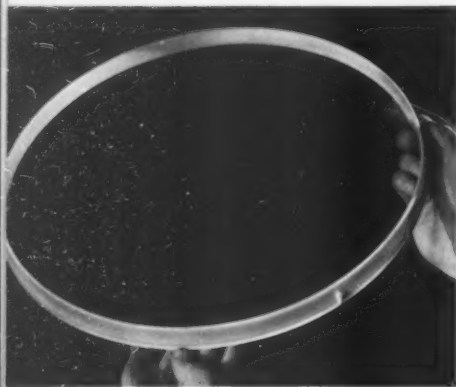
See the next page for more examples of what DELRIN is doing to improve products and reduce costs.



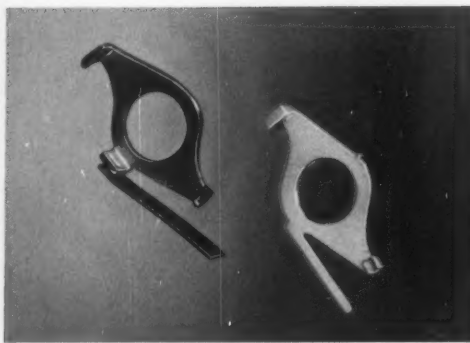
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one of Du Pont's versatile
engineering materials



This molded bearing ring of DELRIN is key unit of a simplified bearing system for the revolving drum of an RCA Whirlpool dryer. The bearing design requirements, which led directly to DELRIN, included excellent frictional properties, abrasion resistance, dimensional stability and retention of physical properties in a moist atmosphere at temperatures up to 200°F., and freedom from warpage. (Molded by Haas Molding Co., Mendon, Michigan, for Whirlpool Corporation, St. Joseph, Michigan.)



DELIN has replaced an expensive two-piece, spot-welded and copperplated, stamped-steel component in fluorescent light-starter switch. The new one-piece injection-molded part is used as a lock spring. DELRIN acetal resin is a good electrical insulator, has excellent resilience, which gives it the spring-like properties needed here, wear resistance and dimensional stability; costs about half of previous metal component. (Molded by Waterbury Company, Waterbury, Connecticut, for Edwin Gaynor Co., Bridgeport, Connecticut.)



A clamp-on hand brake for cotton spinning spindles uses DELRIN for the handle, the cam and two brake arms. The flexing arms of tough, resilient DELRIN provide automatic adjustment and take-up for wear. DELRIN is easily molded in the complex shapes required, eliminates the need for machining operations. (By Brook Molding Company, Norwood, Mass., for Whitin Machine Works, Whitinsville, Mass.)

Light, tough and resilient DELRIN® simplifies designs . . . cuts costs

Sometimes the simple substitution of a part of DELRIN for a metal part answers a design problem and saves money by eliminating finishing operations and making possible rapid, low-cost injection-molding production. Very frequently, however, the use of DELRIN permits a thorough redesign of a component, with increased operating efficiency, fewer parts, lower assembly costs, lower shipping costs. The resultant cost advantages can be substantial. It will be worth your while to investigate the properties of DELRIN as they apply to your design problems, and to find out more about the many hundreds of production improvements at lower cost that this new material has made possible. Simply mail the coupon below for pertinent information.

POLYCHEMICALS DEPARTMENT



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of wire, foil, and semiconductor strain gages; details of gage characteristics; mechanical and electrical aspects of the gage system; electric circuits for strain gages; dynamic and static strain measurements; and measuring systems and instruments. Some laboratory exercises are: Strain gage installation for normal and high-temperature applications, static observations with single and multiple gage bridges, dynamic strain measurements, and characteristics and handling of certain commercial equipment. Further information can be obtained from Engineering Extension, Engineering Bldg. Unit II, Room 6266, University of California, Los Angeles 24, Calif.

Aug. 23-25—

Fourth Biennial Gas Dynamics Symposium to be held at Northwestern University. Sponsors are the Electric Propulsion Committee and the Magnetohydrodynamics Committee of the American Rocket Society and the Gas Dynamics Laboratory of Northwestern. The program will cover transport properties of plasmas, magnetohydrodynamic wave phenomena, experimental techniques and observations, propulsion, power generation, and thermodynamic properties of plasmas. Additional data can be obtained from Gas Dynamics Symposium, Mechanical Engineering Dept., Northwestern University, Evanston, Ill.

Aug. 27-Sept. 1—

Short Course on Materials Under Thermal Stress to be held at Pennsylvania State University. Object of the course is to present intensive treatment of the present state of the art of thermal stress analysis and interpretation. Lecture topics will include elastic analysis, fundamental behavior of materials under mechanical and thermal strain cycling, inelastic analysis, thermal shock of brittle and ductile materials, and choice of materials and mechanical configuration for optimum design. Further information can be obtained from the Conference Center, Pennsylvania State University, University Park, Pa.

Sept. 5-9—

Short Course on Photoelasticity, to be held at the University of California, will review (by means of

lectures, demonstrations, and laboratory exercises) the fundamental theory and laboratory techniques related to the classical applications of polarized light for solving stress problems. The most advanced techniques will also be discussed. Additional information can be obtained from Engineering Extension, Engineering Bldg. Unit II, Room 6266, University of California, Los Angeles 24, Calif.

Sept. 6-8—

Midwest Conference of Fluid and Solid Mechanics, to be held at Michigan State University, will present new research and development work in these two fields. Additional information is available from Dr. Joachim E. Lay, 14 Olds Hall, Michigan State University, East Lansing, Mich.

Sept. 6-8—

Joint Nuclear Instrumentation Symposium, sponsored by Instrument Society of America, American Institute of Electrical Engineers, and Institute of Radio Engineers, to be held at North Carolina State College, Raleigh, N. C. Additional information is available from Meetings Manager, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Sept. 11-22—

Institute on Experimental Stress Analysis, to be held at Wayne State University, will consist of Program 1—Photoelasticity, Theory and Application, and Program 2—Strain Gages, Theory and Application. Program 1 will include: Basic optics, the polariscope, birefringence, isoclinics and stress trajectories, study of separate stresses, model making and machining of photoelastic materials, and photoelastic coatings. Some topics for Program 2 are: Basic mechanics laws, strain-sensitive materials, properties and types of foil and wire gages, adhesives and modes of fastening, strain gage circuits, calibration, types of amplifiers, dynamic measurements, transducer application, and commercial equipment. Further information can be obtained from Dr. Joseph Der Havesian, Institute Co-ordinator, Dept. of Engineering Mechanics,



The new single unitized housing construction on Heinze D Sub-Fractional Horsepower Blowers provides more rugged durability; more efficient air delivery; reduced service costs; and a lower selling price due to lower manufacturing costs.

Housing is CRS with baked enamel finish. Blower is stronger for rough usage — yet inner assembly is easily accessible for servicing.

Blowers are powered by Type D 2 pole shaded pole induction motors, 115 V AC, 60 cycle. Single unit delivers up to 60 cfm, double unit 120 cfm.

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ENGINEERING NEWS

Wayne State University, 655 Mer-
rick, Detroit 2, Mich.

Sept. 12-15—

**Seminar for Manufacturing En-
gineers** to be held at Pennsylvania
State University. It will cover lat-
est techniques related to automa-
tion equipment development for
engineers responsible for the de-
sign, installation, and operation of
such equipment. Further informa-
tion can be obtained from the Con-
ference Center, Pennsylvania State
University, University Park, Pa.

Sept. 20-21—

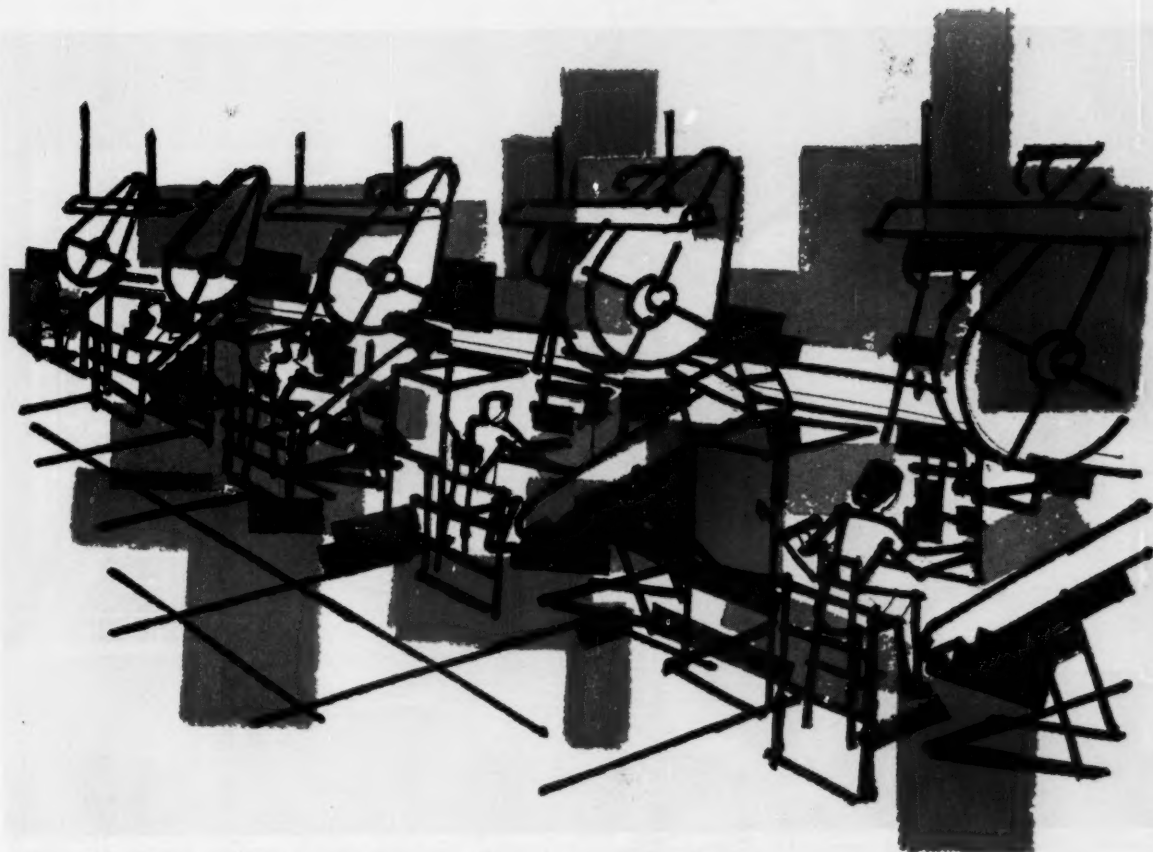
Industrial Electronics Symposium,
sponsored by the American Insti-
tute of Electrical Engineers, the
Professional Group on Industrial
Electronics of the Institute of Radio
Engineers, and the Instrument So-
ciety of America, to be held at the
Bradford Hotel, Boston. Theme of
the symposium will be supplier-user
co-operation. Technical sessions
will be on measuring techniques for
industry, digital and analog tech-
niques in industry, and new power
conversion techniques. Additional
information is available from D. J.
LaCerde, Badger Mfg. Co., 363
Third St., Cambridge, Mass.

Oct. 3-6—

**Ninth Annual Human Engineer-
ing Institute**, conducted by Dunlap
and Associates Inc., to be held in
Stamford, Conn. The program will
consist of three days of technical
sessions, a half-day on manage-
ment and contractual aspects of hu-
man engineering efforts, and an
opportunity for private conferences.
Further information is available
from Dr. Jerome H. Ely, Institute
Director, Dunlap and Associates
Inc., 429 Atlantic St., Stamford,
Conn.

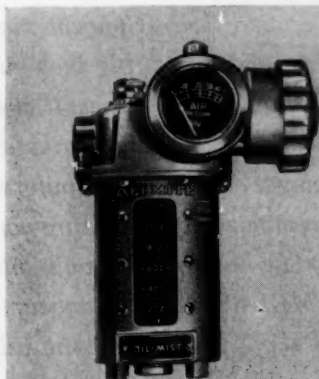
Oct. 25-26—

**Computer Applications Symposi-
um**, sponsored by Armour Research
Foundation, to be held at the Mor-
rison Hotel, Chicago. User expe-
rience in computer application and
programming techniques will be
emphasized. Additional informa-
tion is available from Benjamin
Mittman, program chairman, Ar-
mour Research Foundation, 10 W.
35th St., Chicago 16, Ill.



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ACCUMITE — small, easily installed system gives positive measured shot of oil or light grease to each bearing.

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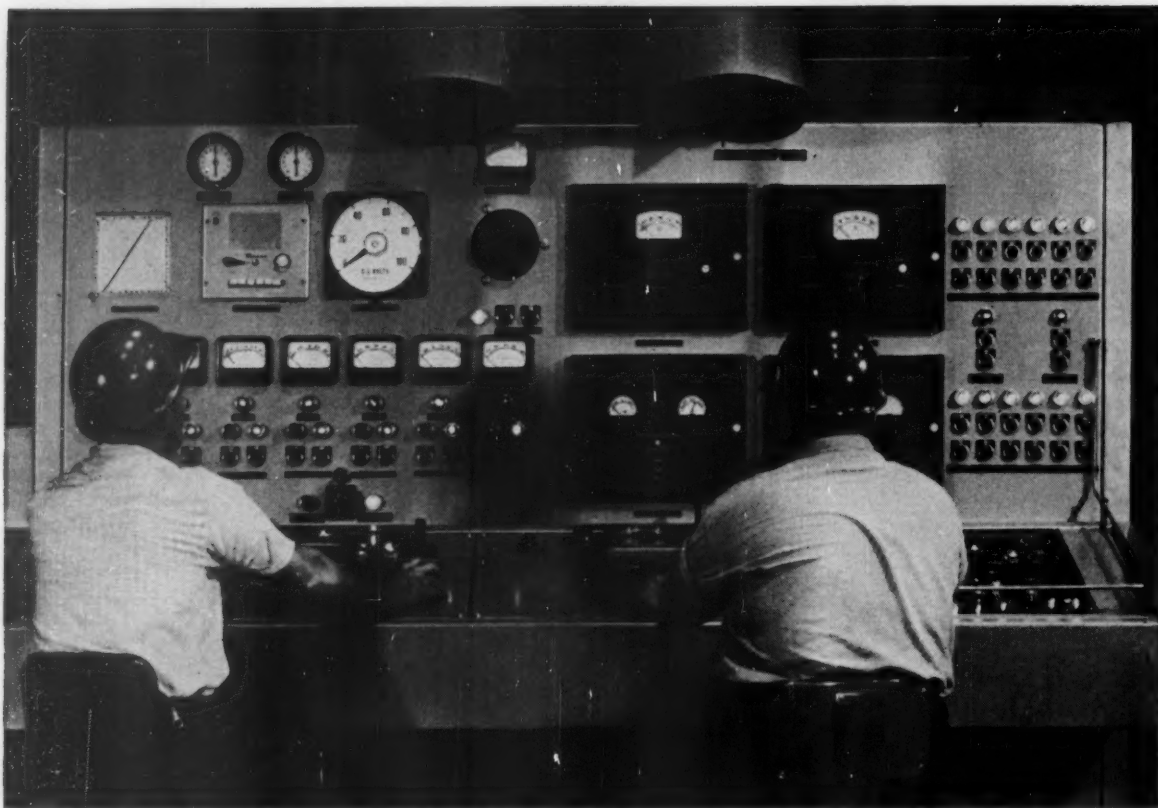
In Canada: Stewart-Warner Corporation of Canada, Ltd., Belleville, Ontario

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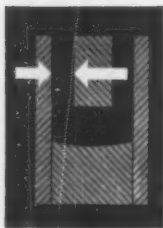


Dept. BB-71, 1850 Diversey Parkway, Chicago 14, Illinois



Control panel of a Carpenter consumable electrode (Consumet) furnace. Electronic circuits maintain positive arc control and precise electrode movement to assure the ultimate in refining.

Where *Carpenter's* "big inch" makes a mile of difference in alloy quality



The "big inch" in Carpenter's consumable electrode (Consumet®) furnace is the extra space between the consumable electrode and the mold wall. (Conventional furnaces of this type are almost $\frac{1}{3}$ smaller at this vital point.) The "big inch" in Carpenter's furnace provides more exhaust space to carry off harmful gases. It also gives Carpenter technicians more precise vacuum control during the arc strike as well as during the entire melting process. As a result, you get cleaner, more uniform alloys from core to surface. Segregation and variation in grain size are minimized . . . to assure you consistent, predictable performance from your vacuum melted alloys. The "big inch" is only one of many exclusive Carpenter quality controls in consumable electrode, MEL-TROL® and vacuum-induction-melted (VacuMeltrol®) specialty steels. Ask your Carpenter representative for the full story behind these alloys and how they benefit you.

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you can do it **consistently** better with Carpenter Specialty Steels for specialists



The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
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Webb Wire Division, North Brunswick, N.J.

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Reasons why Link-Belt ball bearings are "first choice" with design engineers

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- **SIMPLE INSTALLATION**—Steel collar locks bearing securely to shaft. Slotted bolt holes facilitate mounting.
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BALL BEARING PILLOW BLOCKS WITH ONE-PIECE HOUSINGS—Series 200 and 300 pillow blocks for 1/2" to 4" shafts. Most popular housing design! Lubricated . . . ready for installation.



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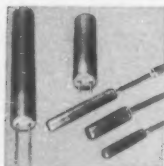
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World.



OEM Guide to Electric Heaters

How to select the exact heating element to meet your product requirements

Here's condensed information from General Electric to help you get the most economical heater for your products.

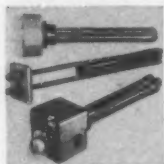


CARTRIDGE HEATERS

- **Applications**—Efficient, self-contained heaters, for use singly to provide a "spot" of heat, or grouped to heat larger surfaces. Perfected for use in process machinery and for localized heating requiring close thermal control: dies, platens, molds, extrusion and injection barrels, gluepots, compound pots.

- **Features**—Durable nickel-chromium resistance wire packed in insulation and sheathed in metal tube.

- **Ratings**—30 to 2800 watts—Sheath temperatures: brass (750F); nickel-silver (1000F); chrome-steel (1200F)—Over-all lengths: 1½ in. to 2 ft.—Diameters: ⅜ in. to 1.293 in.—115v to 230v.



IMMERSION HEATERS

- **Applications**—Offer clean, economical method of heating various liquids in tanks, kettles, jackets and other containers. Suitable for immersion in water, oil, alkaline solutions, nickel, copper, chrome, plating solutions, mild sulphuric acid baths and salt baths.

- **Features**—Long life—Easily installed—Easily controlled—Sealed terminals—Excellent insulation and heat conduction.

- **Ratings**—Both through-the-side and over-the-side models available—Sheath materials: copper, nickel-silver, stainless steel, Inconel and lead—115v to 230v—Wide variety of models from 650 to 10,000 watts.



FIN TUBULAR HEATERS

- **Applications**—Especially suited to forced-convection air heating applications, such as air ducts with forced-air circulation, blower-type electric unit heaters, car heaters, recirculating ovens, industrial processes requiring heated air blasts for drying, baking, testing or pre-heating.

- **Features**—Large radiating surface per unit length—Fins sturdily attached by brazing—Quick heat transfer—Nonoxidizing rust-resistant finish—Durable construction.

- **Ratings**—Wide variety of shapes available—Sheath temperature: steel (850F)—Watts: up to 100 per linear inch.

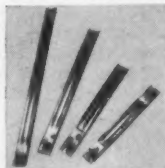


TUBULAR HEATERS

- **Applications**—Applicable to practically every low-temperature (1500F or lower) requirement, whether heating liquids, air, soft metals, or metal surfaces. Typical applications: ovens, ducts, platens, pipes, space heaters.

- **Features**—High-quality resistance wire, insulated in metal tubing—Heaters bent to conform to almost any shape, cast into metal, located in drilled holes, grooves, or spaced away from surfaces.

- **Ratings**—Standard ratings, 500 to 5000 watts; special ratings available—Sheath materials: steel (750F); nickel-silver (1000F); stainless and Inconel (1500F); copper (212F in water).



STRIP HEATERS

- **Applications**—Designed for direct clamping to surfaces. Typical applications: process machinery, drying ovens, matrix scorers, warming tables, glue tables, water baths, drying cabinets, pipelines, incubators, valve and pump houses, telephone switchboards, roll heating, packaging machinery.

- **Features**—Uniform heat distribution—Corrosion-resistant sheath materials—Easy to install—Moderate cost—Uniformity.

- **Ratings**—Provided with offset terminals at one end or terminals at each end—Sheath materials: Aluminized-steel (1000F); Chromized-steel (1200F).

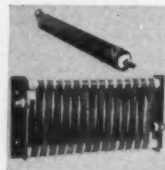


METAL-MELTING HEATERS AND POTS

- **Applications**—Feature cast-in immersion heaters for melting lead, babbitt, tin, solder, type metal and similar metals up to 950F. Applications: dip soldering of subassemblies, railway and repair shops, electric service shops, printing plants, manufacturing plants, remelting metals.

- **Features**—Heat generated right in metal for quick heating, low radiation losses—Heater easily replaced without interrupting production—Reliable, safe, economical—Can be tied in with automatic temperature control.

- **Ratings**—Standard melting pots—Wt. 50 to 2000 lbs—Watts: 750 to 30,000.

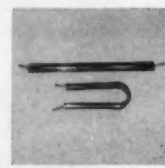


OVEN HEATERS

- **Applications**—Designed for such applications as baking, japan, foundry cores, drying, low-temperature drawing ovens, and for general air heating applications in which there is free movement of air by convection. Heaters used in recirculating type ovens for core baking, paint drying, tempering, air heating in ducts, placement inside oven.

- **Features**—Easily mounted on side walls of oven or in ducts—Wide range in heater ratings and combinations of heaters.

- **Ratings**—Temperatures: Two models available: 750F–1000F, and up to 1200F.



VANE-TYPE HEATERS

- **Applications**—Used for air and surface heating applications: baseboard heaters, pipe heating, platen heating, valve and pump heating, drying cabinets and ovens, process machinery, compound tanks.

- **Features**—Rugged tubular construction resists mechanical shock and vibration—Large, 1½ in. wide radiating surface—Low heat density: 25 watts per linear in. of vane; 14.3 watts per sq. in. of heater surface—Can be easily formed—Convenient mounting holes.

- **Ratings**—Variety of models from 500 to 2500 watts—115 to 230 volts—Over-all lengths: 24 to 104 inches—Maximum operating temperature 750F.



FREE New Catalog of General Electric Calrod® Industrial Heaters and Devices

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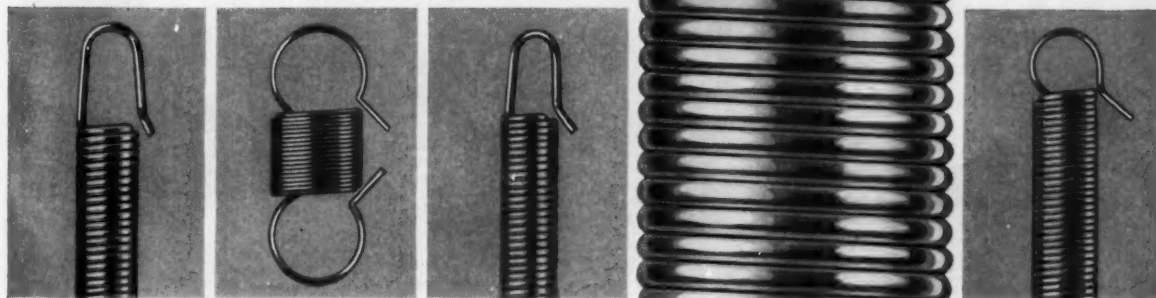
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GENERAL ELECTRIC

Is There a Happy Ending for You in the Tail of this Hook . . . ?



6102

Installation of small extension springs in restricted space was a problem in assembling business machines. Also plagued with the same problem were field servicemen. Development of Easy-on® Hooks provided the happy ending to both situations—opened up new possibilities for wider application.

Shown above are variations of the Easy-on® principle—production-formed extended lips which make it possible to snap on or off the anchoring point with ease. Easy-on® Hooks may be formed at

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Write for "How A.S.C. solves design and production problems of Springs and Spring-like things."



Associated Spring Corporation

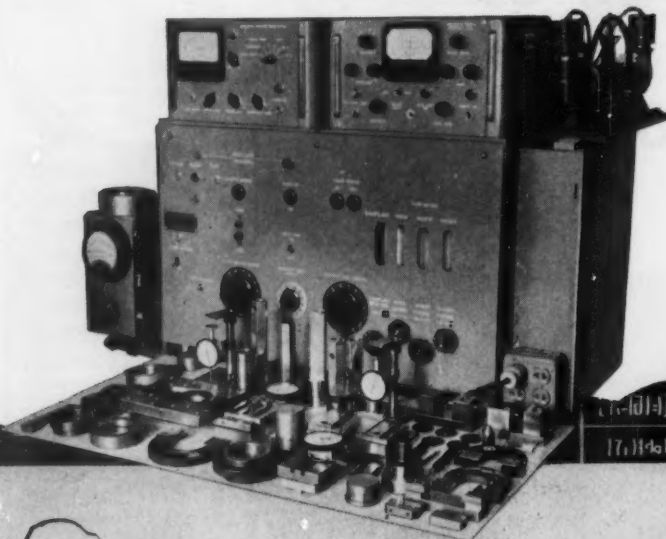
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There are 46 gauges, dial indicators and pressure testing devices shown above. All of these are used to assure the maintenance of the extremely close tolerances required on *just one job*, currently being made by MIRRO.

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Admittedly, this is an unusually demanding contract, calling for extremely precise manufacture and assembly. We cite it as indicative of the precision-potential that you can count on, when you count on MIRRO for contract production of component parts. Regardless of the tolerances that you must maintain, we'd welcome a chance to estimate or advise.

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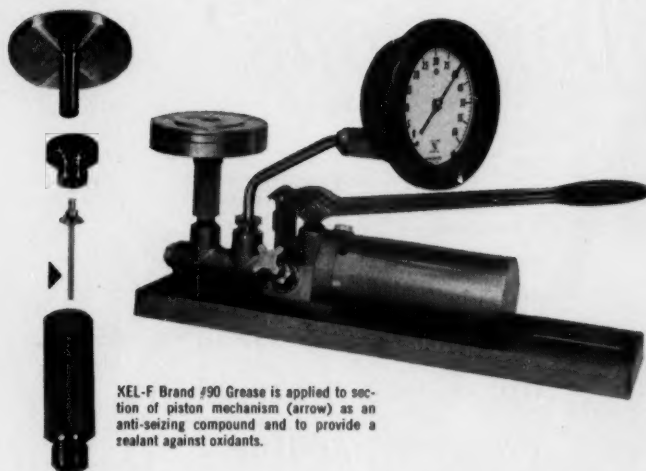
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THE RAW MATERIALS OF PROGRESS

Dead weight tester's piston gets smooth glide with **KEL-F®**

BRAND GREASE



KEL-F Brand #90 Grease is applied to section of piston mechanism (arrow) as an anti-seizing compound and to provide a sealant against oxidants.

Setting up standards by which pressure-measuring devices can be accurately checked and calibrated is the job of the Ashcroft Portable Dead Weight Tester above, a product of Manning, Maxwell and Moore, Inc., Stratford, Conn. KEL-F Brand #90 Grease provides lubrication for the tester's piston mechanism. The inert lubricant functions even when oxygen gauges are being tested; ordinary lubricants may explode in the presence of oxygen.

KEL-F #90 Grease helps ensure instrument accuracy within 1/10 of 1% because it does not

become sticky, does not gum up, reduces piston maintenance and does not wash out with water which is frequently used as the testing fluid.

The dead weight tester utilizes interchangeable pistons for high and low-range pressures. Both of these pistons rely on KEL-F Brand Grease to serve as an anti-seizing compound.

#90 Grease is one of several KEL-F Brand Oils, Waxes and Greases intended for critical applications involving corrosive or reactive chemicals. See the "profile" column at right, then return coupon below.

Chemical Division, Dept. KCG-71
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PROPERTIES PROFILE

ON

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BRAND

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OTHER PROPERTIES. Density may be up to twice the specific gravity of water. Oils are liquid at room temperature, with pour points as low as -80°F. Waxes are solid at room temperature, have a melting point of 100 to 190°F. Greases are compounded oil and wax products containing inert thickeners. They remain semi-solid in their normal operating range of 0 to 350°F.

WANT MORE INFORMATION? Just ask the nearby 3M Chemical Representative. He will provide complete data on KEL-F Oils, Waxes and Greases to help you solve critical application problems. Or write, stating area of interest, to 3M Chemical Division, Dept. KCG-71. St. Paul 6, Minn.

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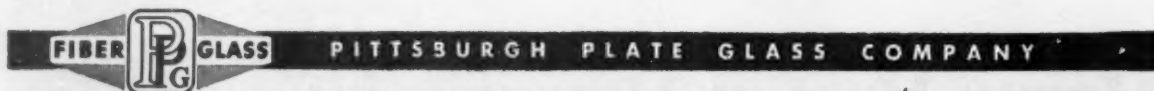
PPG Chopped Strand Mat ... for sheets, boats, high pressure molding

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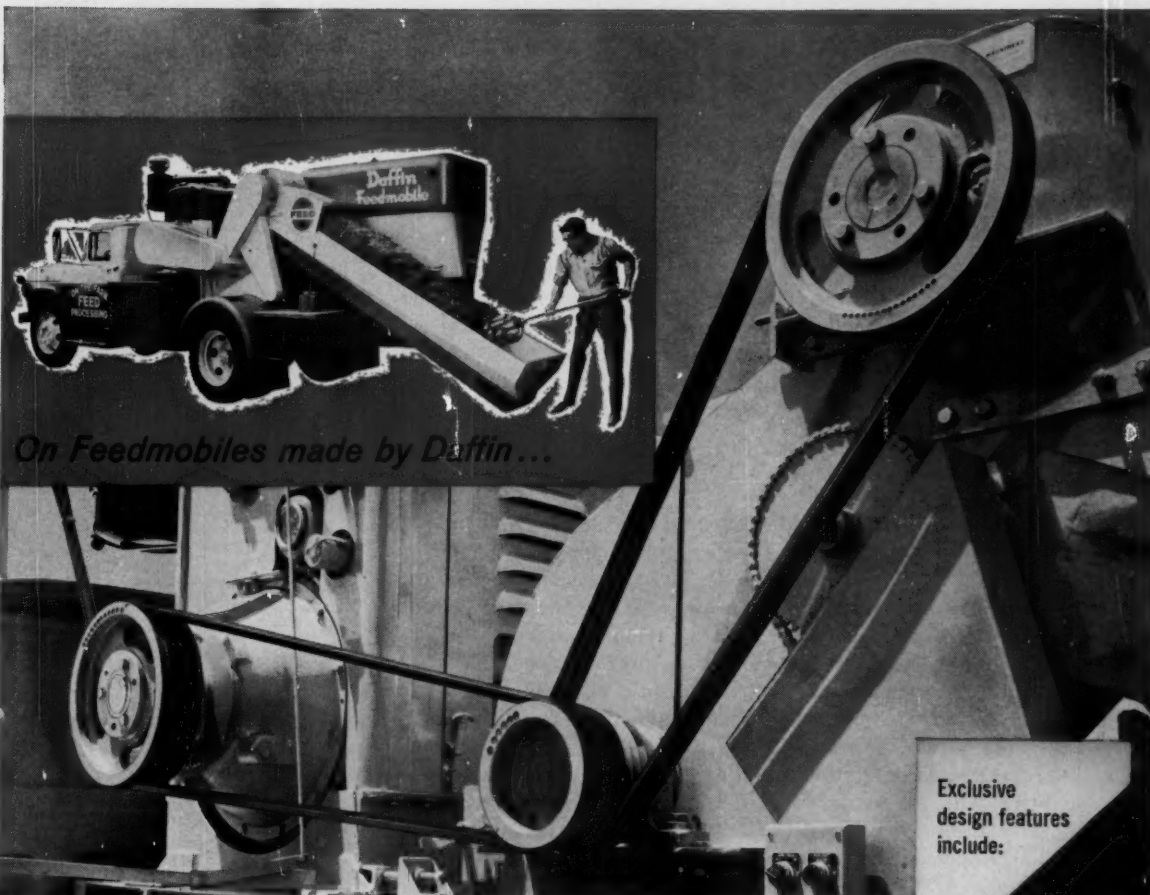
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On Feedmobiles made by Daffin...

Gates Super HC Drives permit power increase of 20hp in less drive space

The Daffin Feedmobile is a well-designed, efficient feed mill on wheels made by Daffin Manufacturing Co. of Lancaster, Pennsylvania. Originally, all the power for grinding, mixing and blending was transmitted by conventional V-belt drives.

Early in 1960, the machine was redesigned to obtain the competitive advantages that result through use of Gates Super HC High Capacity V-Belt Drives.

An official of the company, John Skinner, Jr., says: "The Gates Super HC Drives let us increase the output of the diesel power plant from about 100 HP to 120 HP without reducing the original safety factor. Sheaves are narrower and are about 80 pounds lighter, reducing the overhang load on bearings, increasing bearing life. Guards are 4 inches

narrower, require less metal and are nearly 33% lighter weight. Drive cost for each machine has been cut 7 or 8%."

He says further: "The Gates High Capacity Drives have greatly strengthened one of our most important selling points—the fact that 'there is far less down-time with a Daffin.'"

Manufacturers everywhere have standardized upon the Gates Super HC V-Belt Drive—the first and most advanced high capacity drive. It is your best assurance that your power transmission unit will not soon become obsolete.

The Gates Fieldman located near you is a drive design expert. Contact him for technical information and assistance in designing Gates High Capacity V-Belt Drives.

The Gates Rubber Company, Denver, Colorado

Gates Super HC V-Belt Drives

Exclusive design features include:



precisely engineered arched top, concave sidewalls, Flex-Weave cover, super strength tensile construction.

Gates Super HC Drive saves space, weight and money



Gates

Building the future on 50 years of progress.

How adapters affect "V" packing performance

The widespread popularity of "V" type packings is largely due to their versatility. For low pressure applications, a single "V"—with male and female adapter—may be sufficient. A set, incorporating many "V's", can withstand pressures well over 50,000 psi. They are used in cylinders (inside packed) and on rods (outside packed).

The overall performance, both sealing efficiency and service life, however, is largely dependent on the adapters which support the packings—and primarily on the female adapter because it supports the entire set. Excessive friction, packing extrusion, short service life and failure to properly seal can all result from adapters that are oversize, undersize, or made from materials not suited to the application.

Common Adapter Materials

Adapters are usually made of metal, phenolics, hard homogeneous rubber, fabricated rubber or leather. Each material has its merits and its limitations. In this group there is a range from hard, non-compressible materials to those that are softer and compressible.

What The Female Adapter Must Do

As we said earlier, the female adapter supports the entire set. But that's only part of its job. It must be hard enough to prevent extrusion of the "V" under pressure. Yet it must be soft enough to compress without fracturing. It must "breathe"—compress and flow radially under pressure then recoil when pressure is reduced thereby bridging the metal clearance.

Since "V" packings are in the

category of "lip" type packings, their sealing action is due to the force of the actuating pressure expanding the packing. As a result of this "breathing" action, friction on the return stroke is negligible.

Adapter Material Selection

Now to get back to adapter materials. Metal, usually brass or bronze, is hard and inflexible. It can be machined so that the clearance is held to a minimum but it cannot breathe with the packings. Excessive friction and wear usually result.

Phenolic adapters are only slightly better. They "breathe" very little and at high pressures often fracture.

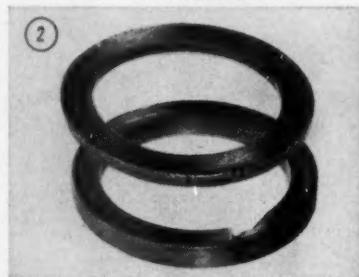
Hard homogeneous rubber, fabricated rubber or leather adapters are superior to both metal and phenolics. This is because these materials are compressible—they will "breathe" with the packing thus bridging the clearance and eliminating extrusion without unnecessary friction.

Homogeneous rubber adapters should be of about 55 Durometer on the "D" scale, fabricated rubber should be a fairly hard texture, and leather adapters are usually impregnated with a hard wax.

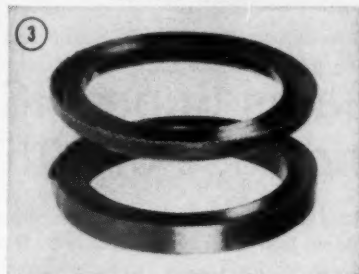
Houghton, the only manufacturer of both packings and fluids for hydraulics, has widespread experience in packing design, application and performance. For unbiased recommendations and help in improving packing performance, write E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.



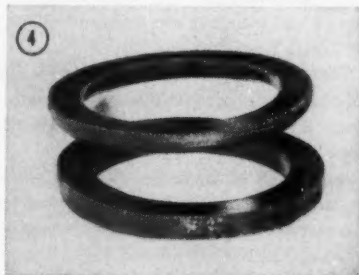
METAL ADAPTER



PHENOLIC ADAPTER



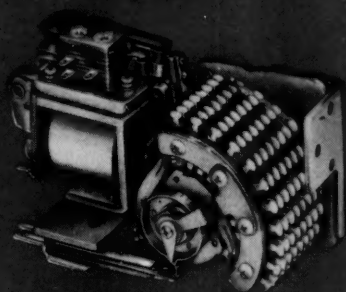
HOMOGENEOUS RUBBER ADAPTER



FABRIC ADAPTER

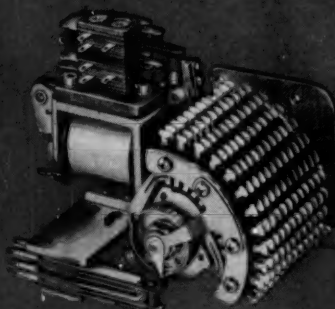
Houghton
INDUSTRY'S PARTNER IN PRODUCTION

SPRING-DRIVEN



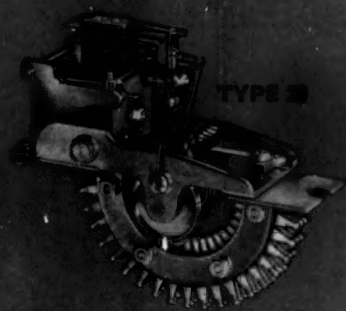
TYPE 210

Up to twelve 10-point levels
or four 30-point levels



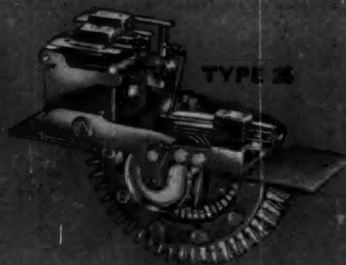
TYPE 211

Up to twelve 11-point levels
or four 33-point levels



TYPE 212

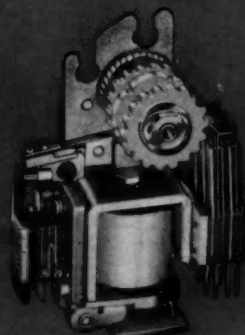
Up to sixteen 20-point levels
or twelve 40-point levels



TYPE 213

Up to sixteen 26-point levels
or twelve 52-point levels

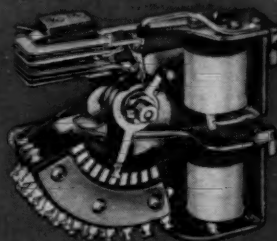
CAM-OPERATED



TYPE 200

Up to eight cams with 30, 32
or 36 tooth ratchets

DIRECT-DRIVE



Up to three 10-point levels

Let Clare put the exactly right stepping switch in your design

Designers who count on CLARE stepping switches as components for complex counting, totalizing and sequence-control equipment know that from the wide CLARE line they can select the exact switch their application requires. If necessary, CLARE engineering will provide special switch designs.

CLARE stepping switches are available as spring-driven, cam-operated or direct-drive switches with capacities from 10 to 52 points. All may be hermetically sealed in nitrogen or oil, or provided with dust covers.

All CLARE stepping switches are well known for their long life, high capacity and minimum maintenance through millions of precise stepping operations. For complete information write for Catalog 202.



**C. P. CLARE & CO., 3101 Pratt Blvd.,
Chicago 45, Illinois. In Canada:
C. P. Clare Canada Ltd., 840 Caledonia Road,
Toronto 19, Ont. Cable address: CLARELAY.**



DAP* INSULATION STANDARD ON SPRING-DRIVEN SWITCHES

FOR—

- High insulation resistance
- Stable insulation resistance
- Good arc resistance
- Strength and stability
- Low moisture absorption

*diallyl phthalate



C. P. CLARE & CO.

*Relays and related
control components*

Circle 232 on Page 19



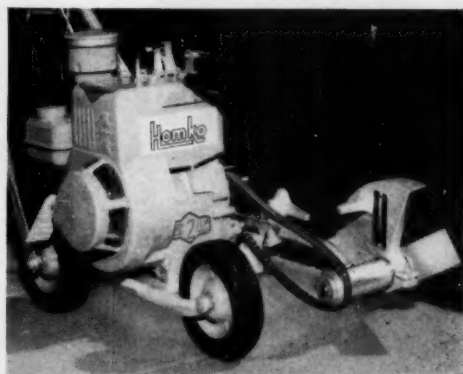
AT THE HEART OF INDUSTRY...



Helping to set a world speed record . . . a U.S. PowerGrip "Timing"® Belt is the key link in the drive train of this Mercury outboard. U.S. "Timing" Belts' positive tooth engagement prevents slippage, insures perfect synchronization. These belts have high flexibility and strong gripping teeth, are backed by steel cord, permit more compact sheaves, need no maintenance.

TB 103

Wherever the design and production of power equipment is involved, you'll find US Industrial Rubber Products...helping to simplify the design, improving the efficiency and reliability of equipment both new and old, adding to the profit of manufacturer and operator alike.



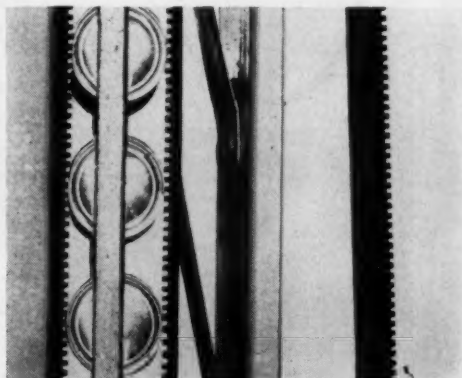
Chosen for overall top performance, U. S. Royal V-Belts drive the edger blade on Western Tool & Stamping Company's powerful Edger-trimmer. These belts must withstand oil, dust, weather, and twisting. They must also deliver top performance at many different engine speeds. U. S. Royal V-Belts do the job... were chosen because they outperformed all competitive belts.

VB 104



Providing better steering control for Clarke's new Power Sweeper, a U.S. PowerGrip Flexible Coupling has eliminated cumbersome, costly metal parts and their need for lubrication... provides quieter, cushioned, yet responsive steering. These easily installed couplings not only compensate for lateral and axial misalignment, but reduce vibration and absorb jarring shocks.

FC 103



"Nothing short of spectacular," says an Anheuser-Busch brewery manager about two U. S. SteepGrade Conveyor Belts that lift wet 16-oz. beer cans at a 90° angle. The secret of this non-slip operation is SteepGrade's "gripper cleat" construction which holds the cans firmly, yet gently, allows less pressure and belt speed, eliminates damage to cans and smearing of print.

CB 124

For every industrial rubber product need, turn to **US**. For Conveyor Belts, V-Belts, the original PowerGrip "Timing"® Belt, Flexible Couplings, Mountings, Fenders, Hose and Packings... custom-designed rubber products of every de-

scription. Discover why U. S. Rubber has become the largest developer and producer of industrial rubber products in the world. See your U. S. Rubber Distributor or contact **US** directly at Rockefeller Center, New York 20, N. Y.

WORLD'S LARGEST MANUFACTURER
OF INDUSTRIAL RUBBER PRODUCTS



United States Rubber

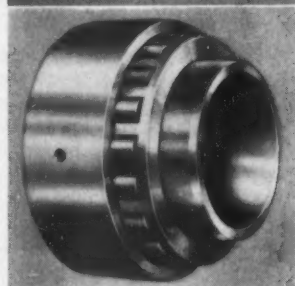
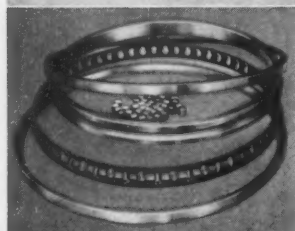
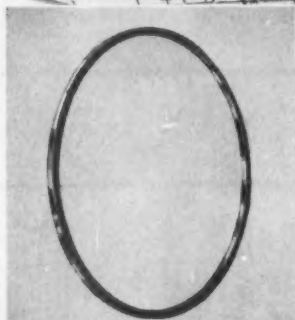
MECHANICAL GOODS DIVISION

Circle 234 on Page 19



"That's good design...
but won't **BEARINGS**
be a problem?"

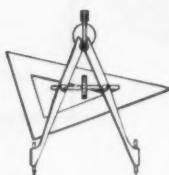
"I doubt it...
we'll check with
MESSINGER."



To "check with Messinger" at the drawing board stage is bound to result in bearings correctly tailored to the design, no matter what problems of size, shape, weight and capacity are involved.

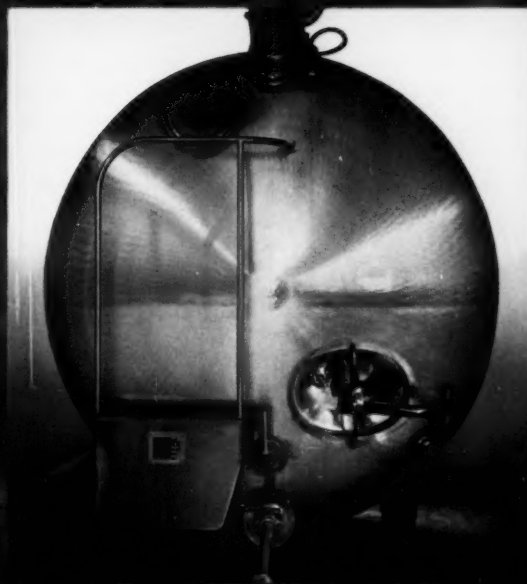
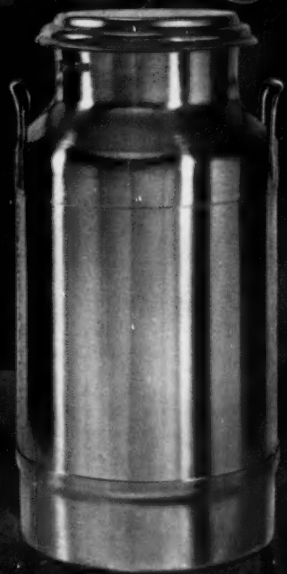
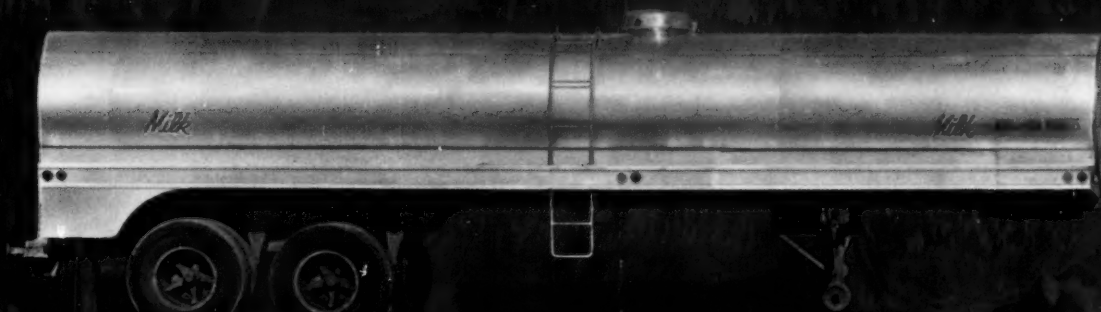
Also, regardless of type, the Messinger Bearings selected can be relied on for long service life with improved over-all product performance.

Four types of Messinger Bearings are illustrated, covering the widest range of applications... from smallest instruments to largest presses, mills, gun turrets and radar scanning screens. Top to bottom: "Featherweight" Bearing; "X" Roller Bearing; Radial Roller Bearing; Thrust Roller Bearing. Catalog 56 completely describes these and other types available.



Designing a new product? "Check with Messinger" before attempting to build it around any standard bearing specifications. The latitude permitted may surprise you.

MESSINGER  **BEARINGS, Inc.**
ROLLER AND BALL BEARINGS FEATHERWEIGHT TO HEAVYWEIGHT
D STREET ABOVE ERIE AVE. • PHILADELPHIA 24, PA.
"Smoothing Industry's Pathway for Nearly Half a Century"



Grade "A" down the shipping line

Few applications demand so much from a metal as those in the dairy industry. Equipment which comes in contact with milk must be completely corrosion-resistant, easy to keep hygienically clean, and practically indestructible. For years many metals were tested and today, from milk pail to bottle-filler, virtually every piece of equipment used in the handling and processing of milk is made of stainless steel.

Product reliability like this depends on uniformity of both

materials and production—the reason J&L stainless is bought regularly by dairy equipment manufacturers. J&L delivers quality consistently, order after order, to help you send Grade A products down the shipping line.

Get consistent quality stainless steel from your J&L distributor, as you need it, *when* you need it. He can also provide technical assistance.



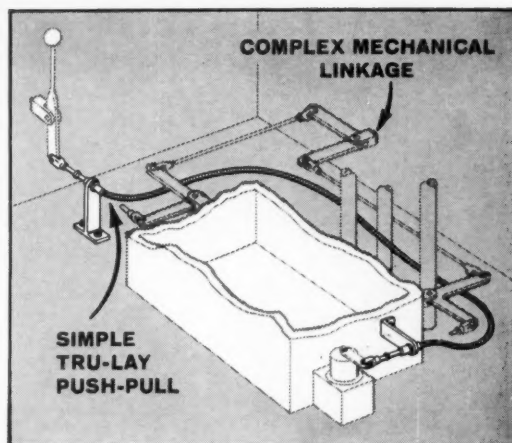
Jones & Laughlin Steel Corporation
STAINLESS and STRIP DIVISION • DETROIT 34



ACCURATE REMOTE CONTROL FOR HUNDREDS OF PRODUCTS

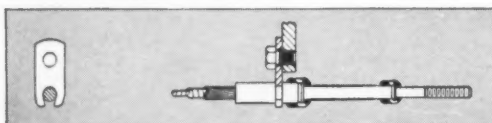
— with Tru-Lay *PUSH-PULL* Controls

If your products involve remote control—electrical, hydraulic, pneumatic or direct—TRU-LAY PUSH-PULL FLEXIBLE CONTROLS can help solve your design problems. They provide positive remote control over short or long distances—up to 150 feet from the control point. Because they operate while flexing, they can snake around obstructions. They will not buckle. They are ruggedly constructed, easily installed and operated, sealed against dirt and moisture, and will handle jobs with as much as 1,000 lbs. input. PUSH-PULL CONTROLS are simple, have but one moving part, are noiseless and give a lifetime of accuracy. Mechanical linkages, on the other hand, are complex. Unlike PUSH-PULL CONTROLS, they are made of many parts, wear at many points, and produce increased backlash, vibration rattles and lost accuracy.

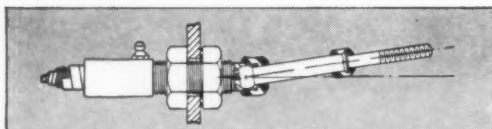


THESE FEATURES HELP SOLVE DESIGN PROBLEMS

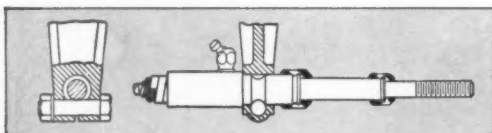
Anchorage



Clip anchorage • a simple clip for light loads

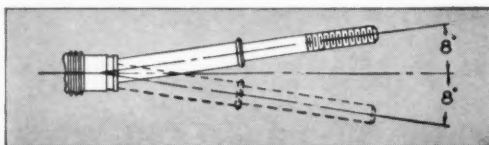


Bulkhead anchorage • for heavy-duty installations



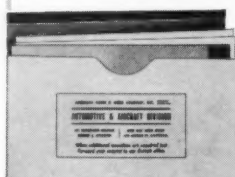
Machined bracket anchorage • can be furnished for mounting any PUSH-PULL cable at the swivel terminal

Swivel Action



Standard assemblies have end fittings with a swivel movement of $\pm 8^\circ$ to compensate for misalignment and rise or fall of lever arms. Swivel joints, and the sliding ends, are sealed against dirt and moisture.

PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY, IMPROVE DESIGN



• Write for your PUSH-PULL Data File. It contains a complete set of engineering bulletins which describe in detail the operation of PUSH-PULL CONTROLS, their applications, features and advantages.

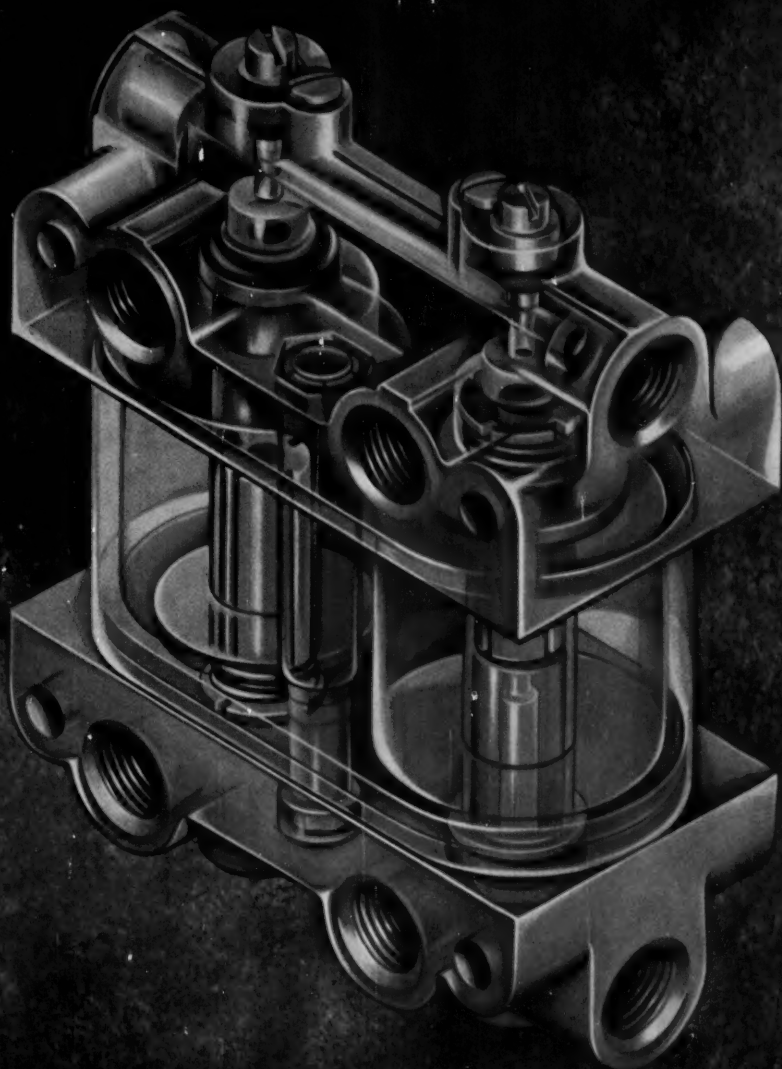


PUSH-PULL CONTROLS

Automotive and Aircraft Division • American Chain & Cable Company, Inc.

601-A Stephenson Bldg., Detroit 2

6800-A East Acco Street, Los Angeles 22 • 929-A Connecticut Ave., Bridgeport 2, Conn.



Compact 4-way

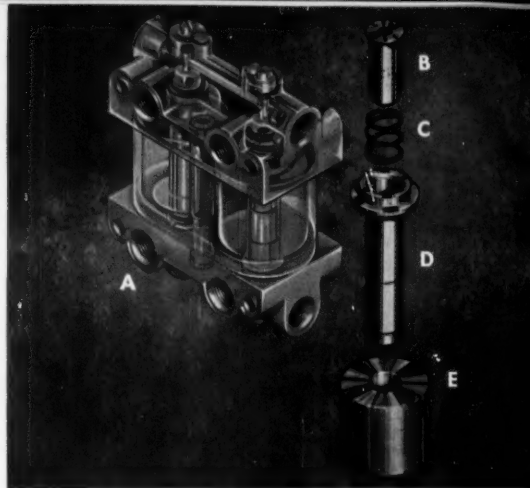
SKINNER

Solenoid Valves

assure precise cylinder control

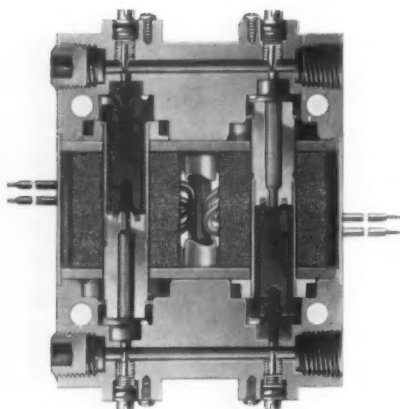
Here's how accurate, dependable operation is built into SKINNER 4-way solenoid valves

- Precise flow control—by adjustable metering
- Compact, direct acting—two 3-way valves in one housing
- Durable and corrosion resistant—stainless steel internal parts
- Leakproof, bubbletight sealing—soft, synthetic inserts
- Positive operation mounted in any position—spring-loaded plungers
- Underwriters approved—wide selection of coils, voltages and frequencies
- Wired from front or rear—housing easily reversed
- Adaptable to many uses—optional porting arrangements



A. Transparent view of 4-way solenoid valve B. Plunger
C. Plunger return spring D. Sleeve E. Coil

SKINNER four-way solenoid valves available in three basic types



The Skinner V9 solenoid valve is two 3-way valves in one compact housing. Both valves may be independently controlled and metered to provide accurate, dependable control of single- or double-acting cylinders, or larger pilot-operated valves.

V9 types are available without adjustable flow and with metering at both exhaust ports, both inlet ports or full metering of all ports.

• • •

For complete information, contact a Skinner Distributor listed in the Yellow Pages or write us at the address below.

V9 SERIES SPECIFICATIONS

Media—air, hydraulic oils, inert gases

Orifice Diameter— $\frac{3}{64}$ ", $\frac{1}{16}$ ", $\frac{3}{32}$ ", $\frac{1}{8}$ "

Pipe Size— $\frac{1}{4}$ " NPTF

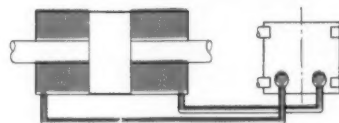
Maximum Operating Pressure Differential—0 to 150 PSI
(up to 225 PSI also available)

Temperature Range—minus 40°F. to plus 180°F.

Cv Factor— $\frac{3}{64}$ " .052, $\frac{1}{16}$ " .095, $\frac{3}{32}$ " .156, $\frac{1}{8}$ " .214

Mounting— $\frac{1}{4}$ " through-bolt holes.

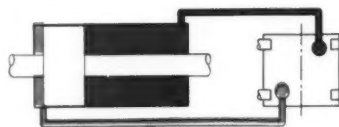
Normally closed—normally closed V933 valves with a neutral position. Generally applied on double-acting cylinders where the piston is in a neutral position without pressure when both coils are de-energized. This permits manual shifting of the piston without operating the valve.



Normally open—normally open V955 valves with a neutral position. Generally applied on double-acting cylinders where both sides of the piston are to be open to pressure when both coils are de-energized. Under certain conditions, the first operating stroke of double-acting cylinders will be smoother with this valve in use.



Normally closed—normally open V935 valves with no neutral position. Generally applied on double-acting cylinders where the piston is to be in retracted or extended position with pressure when both coils are de-energized. Wiring is simple—both coils are operated simultaneously and can be controlled by one single-pole, single-throw switch.



When you specify solenoid valves, specify Skinner. Skinner solenoid valves are distributed nationally.

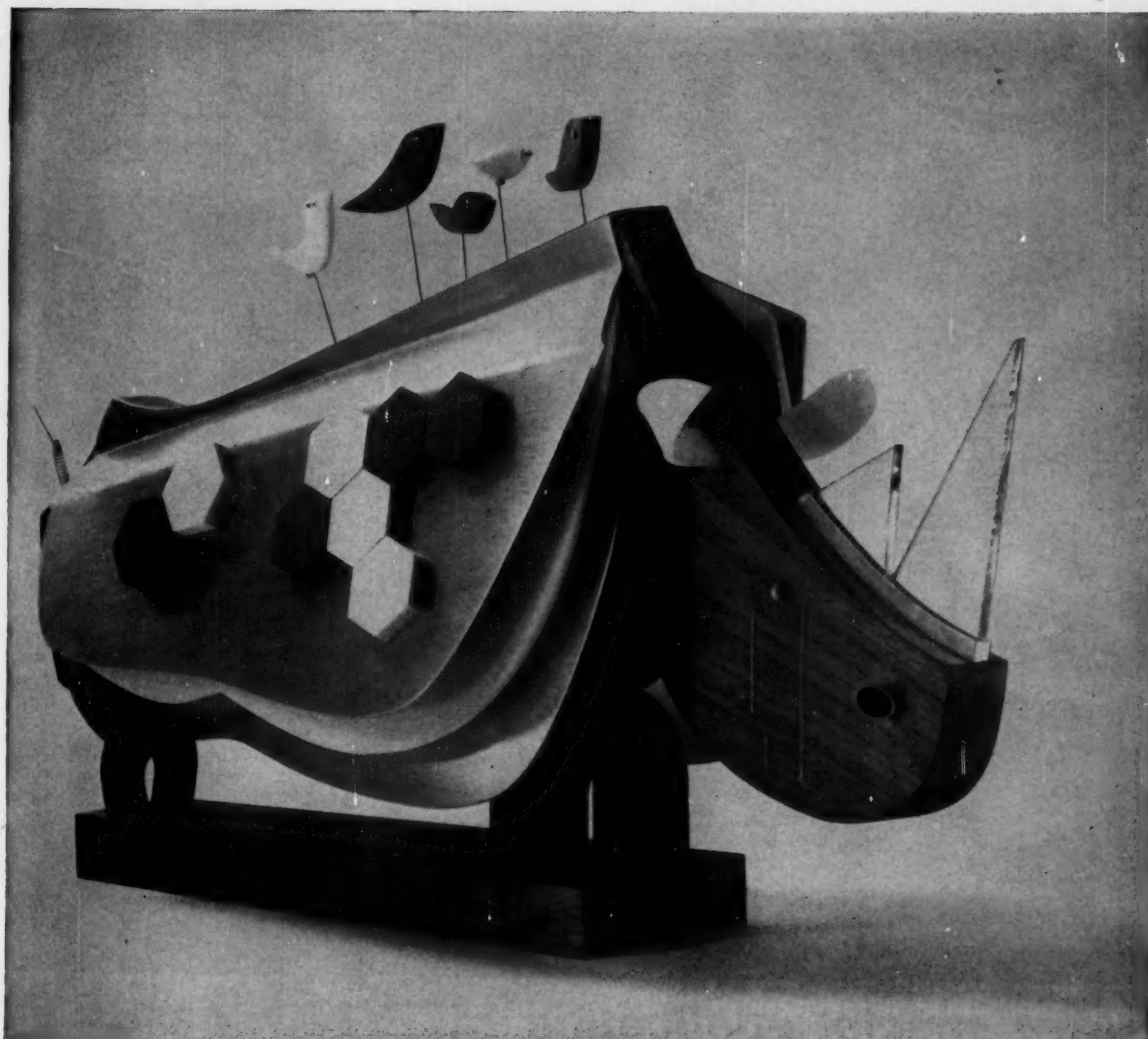


SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
SKINNER PRECISION INDUSTRIES, INC. • NEW BRITAIN, CONNECTICUT, U.S.A.

PRINTED IN U.S.A.



Sculpture created especially for 3M Company by Guy Palazzola

STRENGTH

... Bonds "strong as a bull rhinoceros" made with SCOTCH-WELD®
Brand Structural Adhesives

Whatever materials you're bonding (to the same or to another material), a SCOTCH-WELD Brand Structural Adhesive bond will give you a bonus of structural strength at the joint, with the flexibility to resist vibrational fatigue. SCOTCH-WELD adhesive bonds distribute stress loads uniformly, and protect the strength and integrity of the materials by eliminating fastening holes, maintaining the finish, and sealing joints against corrosion.

Fatigue tests show that metal-to-metal joints in Convair's 880 jet transports and Air Force F-102A jet interceptors, bonded with SCOTCH-WELD adhesives, will outlast the metal structure they bond together! In industry, too, SCOTCH-WELD adhesives are finding use in joining hermetically sealed metal shipping containers, multiple piece castings and thinner gauge metals,

where tear strength would limit the effectiveness of other joining methods.

Look first to 3M! A pioneer in adhesive research, 3M has developed the widest line of adhesives in the industry. These Technical Service facilities are at your disposal. For an accurate appraisal of how an adhesive can add strength, light weight, production economy, and greater design freedom to your process or product, call your nearest 3M Field Engineer or write to: AC&S Division, 3M Company, Department SBR-71, St. Paul 6, Minnesota.

"SCOTCH-WELD" is a Reg. T.M. of 3M Co. © 3M Co., 1961.



What do you want to bond to what?

The 3M Rhino is fabricated of these materials and bonded with SCOTCH-WELD Brand Structural Adhesives:

1. Wood 2. Aluminum 3. Glass 4. Ceramic
5. Plastic 6. Permanent Magnet 7. Brass

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

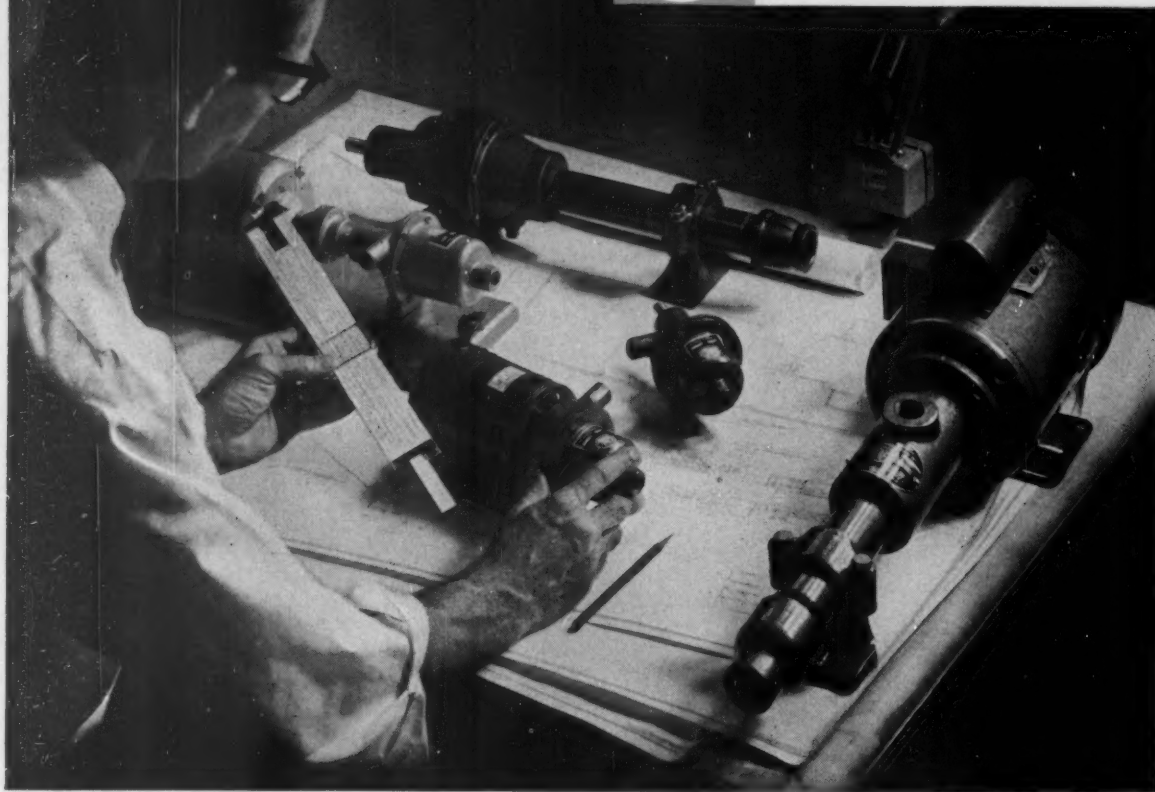
... WHERE RESEARCH IS THE KEY TO TOMORROW





special application

MOYNO® PUMPS



New special application MOYNO® pumps solve many product problems!

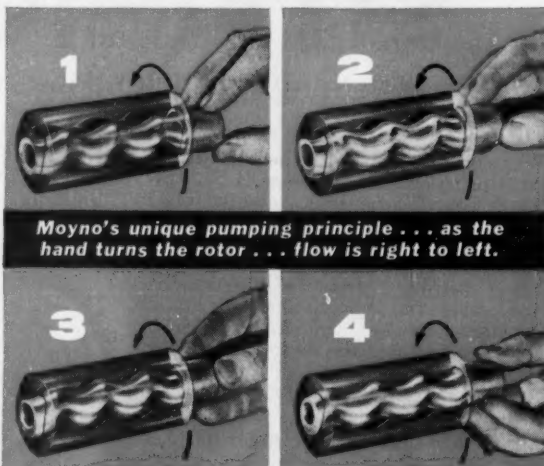


Here is a completely new concept in small pumps. These Moynos successfully handle materials ranging from watery liquids and abrasive slurries to large particles in suspension. They use a single moving pumping element

... have no pistons, valves, high-speed impellers or other quick-wearing parts. Moynos easily handle solids and abrasives that ruin piston pumps. They minimize sealing surface problems common to rotary pumps ... don't cause foaming and aeration like centrifugal pumps do.

Moyno Special Application Pumps are available in two basic designs, each with or without direct-connected motor, in capacities up to 1200 gph and pressures to 300 psi. If your pumping requirements are so special that custom-designed Moynos are indicated, our engineers will examine your problem and recommend Moynos specifically suited to your needs.

Write today for copy of new Moyno bulletin 55-MD



Moyno's unique pumping principle ... as the hand turns the rotor ... flow is right to left.

ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors • Electric Hoists and Overhead Traveling Cranes • Moyno® Industrial Pumps
Propellor® Industrial Fans • R & M-Hunter Fans and Electric Heat • Trade-Wind Range Hoods and Ventilators
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.

THIS IS NEW!



INDUSTRIAL TIMER *Dual-Trol* Recycling Timer

Dual-Trol represents a broad new modular concept of automatic timing control far more flexible, reliable, and practical than anything before.

It is engineered and designed for easy installation and interchange of ten different modular timer units that can be paired to provide limitless combinations of on-off cycles—from 6 seconds to 3 hours.

Dual-Trol is extremely compact (7½" x 6" x 5") and features isolated load contacts, and adjustable dials for setting the desired on-off sequence.

Get our Dual-Trol Bulletin 501 with the details of this significant new automatic timing device for industrial processes. Simply send the coupon.

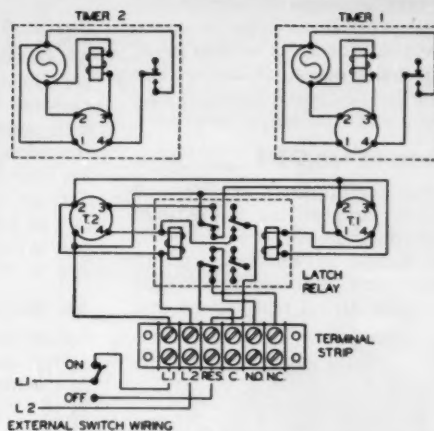


INDUSTRIAL TIMER CORPORATION

1404 McCarter Highway • Newark 4, New Jersey

Manufactured and sold in Canada by SPERRY GYROSCOPE OTTAWA LIMITED
3 Hamilton Ave., Ottawa, Canada • PA 8-4881

Circle 252 on Page 19



INDUSTRIAL TIMER CORPORATION

1404 McCarter Highway • Newark, New Jersey

Gentlemen:

Please send me your Dual-Trol Bulletin 501.

Name _____

Title _____

Company _____

Address _____

City _____ Zone _____ State _____

How to get a pump and motor into the smallest possible space

by E. H. Schanzlin

Chief Engineer, Tuthill Pump Company

Today's designer faces stringent limitations on space and weight in more and more of his assignments. Miniaturization is the order of the day. Even if we exclude rockets, missiles, aircraft and similar applications, reducing the size and weight of pump and motor combinations can result in significant savings.

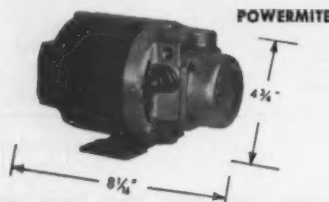
Compactness simplifies assembly operations . . . lowers production costs. Reduced weight means lower shipping expense. Elimination of components such as couplings, bases and adapters can mean substantial savings. And often a compact unit can provide the only feasible answer to a tough design problem.

Special Combinations Developed

Five years ago, Tuthill's engineering department initiated a special program to develop compact pump and motor combinations to provide the greatest possible savings in space and weight. The units on this page, plus others in our stock and on the drawing boards, are a result of this intensive and continuing program.

Powermite for OEM

For original equipment applications involving substantial quantities, Tuthill's engineers have developed a special design in which the pump and motor are combined in one unit which takes up no more space and



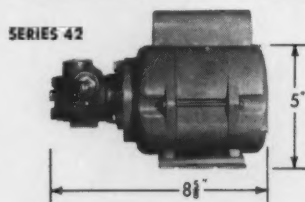
weighs no more than a standard electric motor. The typical Powermite above, used in a hydraulic application, has a capacity of 16 gph

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 gpm; for pressures to 1500 psi; speeds to 3600 rpm.

at 350 psi despite its small size. Each Powermite is specially designed to meet the exact requirements of a specific OEM application.

Standard Units from Stock

In addition, Tuthill provides a wide selection of standard combinations immediately available from stock. Unlike the Powermite, the stock combinations can be furnished in single units, or any desired quantity.



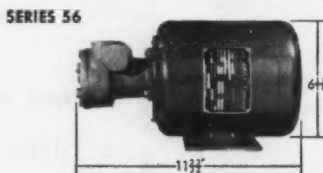
Here is a typical combination . . . series 42 totally enclosed ball bearing motors supplied with ratings from 1/12 to 1/6 hp, in combination with pumps with capacities of 20 to 45 gph at pressures to 200 psi.

Series 48 Combinations

A selection of series 48 combinations are normally supplied with totally enclosed fan-cooled motors of either split phase, capacitor or 3 phase construction, with ratings from 1/4 to 1/2 hp. Pumps supplied in these combinations range from 20 gph to 360 gph at pressures to 360 psi. A typical combination measures only 7 5/8" x 10 7/16".

Series 56 Units Available

Series 56 units measure 6 1/16" x 11 23/32" as shown. They are offered in a complete range of motors from 1/4 to 1 hp . . . which can be coupled



with pumps with capacities from 20 to 360 gph at pressures to 500 psi.

Many Others Available

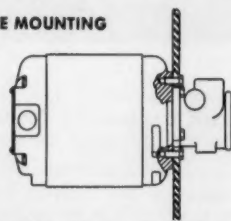
Many other pump and motor combinations are available with capacities up to 50 gpm and for pressures to 500 psi. A new selection of closed coupled units will soon be offered with motor ratings to 5 hp.

Motors are normally furnished for 1725 rpm. However, they are usually available for 3450 and 1140 rpm as well. Explosion proof construction and double shaft extensions on motors are also furnished. Built-in relief valves and other modifications are optional.

Special Flange for Plate Mounting

For many applications a special mounting for close-coupled pump-motor combinations offers distinct advantages. Shown below, it allows the pump and motor to be mounted on any plate of sufficient thickness to bear the weight of the unit, by simply cutting a circular hole of sufficient size to allow the passage of the pump. It is particularly convenient for mounting on tanks, where it greatly simplifies piping arrangements. Through elimination of mounting flanges it further reduces space and weight.

PLATE MOUNTING



Send Us Your Problem

In addition to these, Tuthill has developed a wide range of solutions to special problems involving pump-motor combinations. If you are trying to fit a pump and motor into a small space, take advantage of our experience. Write and give us the details.



TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois



MACHINE DESIGN

PLANOID® GEARS are low-ratio gears competitive with bevel and hypoid gears in efficiency and performance, but are manufactured at lower cost.

**From
Illinois Tool Works'
unique
family
of
gears ...**

SPIROID® GEARS

new gear economies
with new gear efficiencies

HELICON® GEARS bring even greater production economy to high quantity applications than is possible with face, bevel or worm gears.

Shown here are typical examples of outstanding developments in right-angle gearing introduced by Illinois Tool Works. Pictured above is a Spiroid gear, the first major advancement in gearing in thirty years.

Spiroid® Gears do the same job as worm gears with this notable exception: they do it more economically and more efficiently in less space. They are recommended for application in the field of medium to high-ratio right-angle gearing. For maximum economy they may be sintered, molded or cast in metal or plastic; however, even hardened steel Spiroid gears for maximum power transmission are manufactured more cheaply than worm gears.

SEND TODAY FOR THESE NEW GEAR BOOKLETS Free booklets are available giving complete information on the design, manufacture, applications and advantages of each of these gears. Request your copies today.

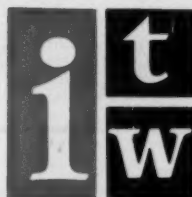


Spiroid® gears

SPIROID DIVISION OF ILLINOIS TOOL WORKS

Circle 254 on Page 19

2501 North Keeler Avenue, Chicago 39, Illinois



Captive Quick-Opening Fasteners:

Southco standards provide many benefits at low cost for access through doors, covers, panels and into drawers

	<p>LION 1/4 TURN FASTENERS</p> <p>Quick, positive locking, by fractional turn. Tight seal formed by compression of leaf spring. Alignment and stack height not critical. Approved for aircraft use. Rugged. Extra strength provided by swaged nose. Vibration resistant.</p>	<p>FOR COUNTERSUNK</p> <p>FOR OVAL HEAD</p>	
	<p>RETRACTABLE SCREW FASTENERS</p> <p>Stand-off thumb screws from stock to eliminate costly, special fasteners. Installed quickly without special tools. Accommodate misalignment. Complete range of standard sizes.</p>		
	<p>ADJUSTABLE PAWL FASTENERS</p> <p>Pre-assembled, quickly installed. Accommodate variations in frame thickness up to 1/2 inch. One-quarter turn closes, additional turns increase grip pressure. Attractive appearance, long life. Moving or pre-set pawl. Miniature, intermediate and large sizes.</p>		<p>MOVING</p> <p>PRESET</p>
	<p>ADJUSTABLE PAWL FASTENER</p> <p>Has twin-knob control. One knob controls pawl, pointer shows pawl position. Other knob controls amount of pressure to seal closure with uniform pre-set compression. Easily installed.</p>		
	<p>ADJUSTABLE PAWL FASTENER</p> <p>Compact and rugged. Eliminates rivets or bolts to save installation time. Three types cover grip range up to 3/4". Supplied either with integral metal and plastic knob, plastic knob or for your knob.</p>		
	<p>ARROWHEAD DOOR LATCH</p> <p>Requires only one hole to install. Operates on quarter turn. Holds under spring tension. Arrow shows pawl position; no pawl stops required. Uses minimum inside space.</p>		

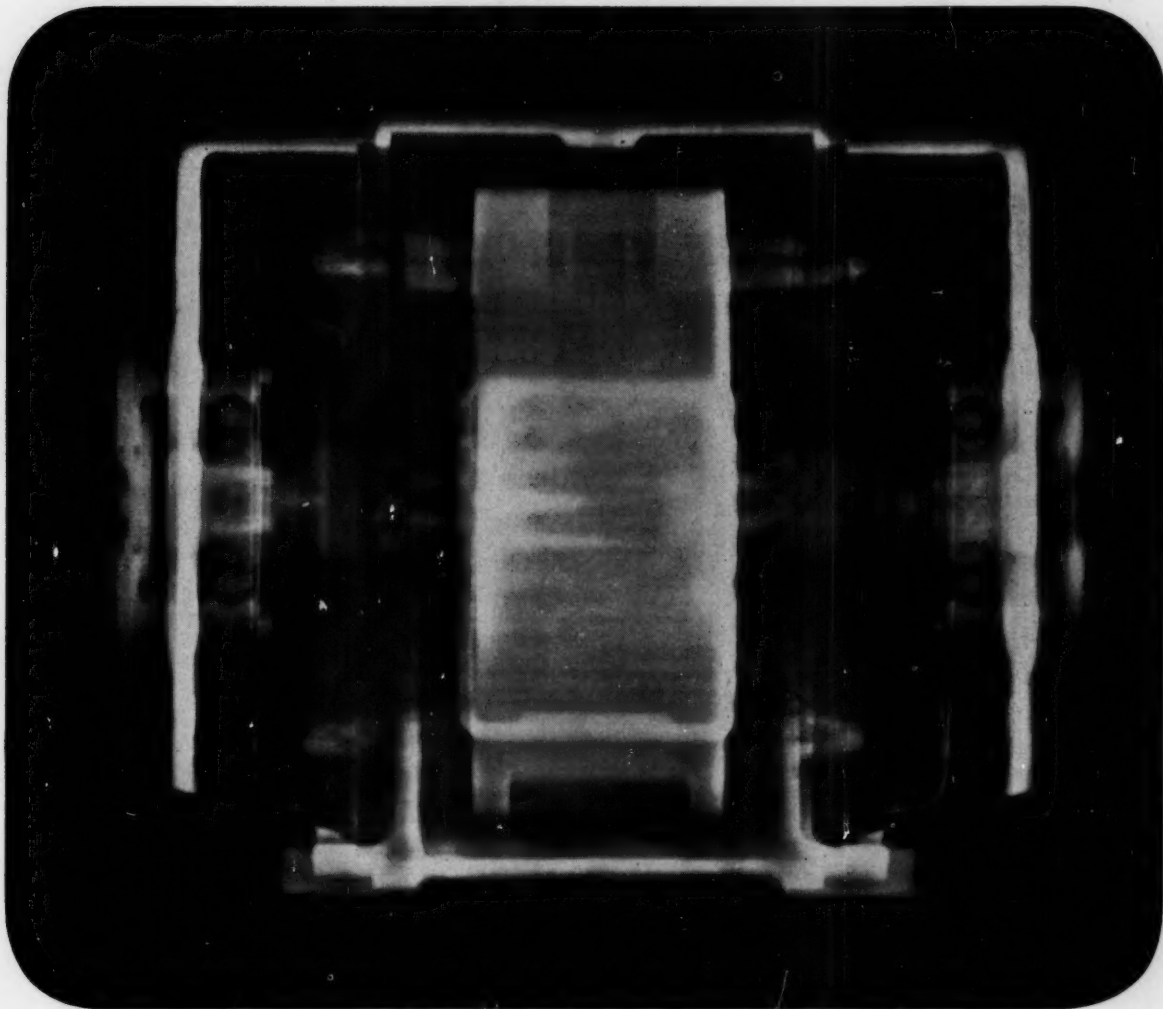
Free Fastener Handbook

Send for your complete Southco Fastener Handbook, just printed. Write to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.



SOUTHCO FASTENERS
© 1959 **LION**

ALLIS-CHALMERS



Actual radiograph of a 5-hp open-type motor taken with a 24-million volt Allis-Chalmers Betatron.

X-ray view of motor health

Invisible standards of perfection increase life expectancy of every Allis-Chalmers motor

The exceptionally long performance of A-C open motors proves the value of thinking *beyond* established standards of design . . . of taking "significant new achievement" as the ideal.

This ideal led to many refinements for A-C open motors: double-shielded bearings that keep dirt out and allow controlled migration of grease, permanently numbered leads for easy identification and connection, and heavy-duty cast iron

frames that resist corrosion and keep rotating parts perfectly aligned.

For totally-enclosed, open-type and *Super-Seal* general purpose motors, and electrically or mechanically modified definite-purpose motors, choose the motor built to invisible standards of perfection. Choose A-C. Special application help available.

Call your nearby A-C representative. Or write **Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.** *Super-Seal* is an Allis-Chalmers trademark.





A PENNY FOR YOUR THOUGHTS!

Design an aluminum extrusion, win \$2500, \$1000 or one of five \$100 awards.

SOME WORDS OF ENCOURAGEMENT

It makes no difference whether your design idea is only now budding in your imagination, nurtured on your drawing board . . . accepted, rejected or utilized by your company. All designs using aluminum extrusions are welcome.

Whatever you're designing now, complete product or component part . . . try redesigning it using aluminum extrusions. Maybe a sticky design problem can be solved by developing a never-before-extruded shape that will take the place of a machined, formed or welded assembly, or one that, when sawed into sections, will reduce machining cost . . . or provide other product benefits.

First Place Winner Will Receive \$2500. Runner-Up Will Win \$1000. And Five Third Place Entries Take \$100. each. All Entrants Receive a Bright, New Penny!

THE JUDGES AND HOW THEY CAN HELP YOU WIN

The top twelve designs selected by Kaiser Aluminum will then be finally judged by executives of the Independent Extruders listed on the opposite page. Your entry will be judged on the basis of originality of concept, product improvements, production cost and time savings, and other resultant or projected advantages that aluminum extrusions make possible.

For a better idea of the vast applications for extrusions and for any technical assistance you may need, contact the Independent Extruder nearest you (see list on opposite page). You can call on his and Kaiser Aluminum's vast extrusion experience to give you expert technical guidance in selection of alloys, tolerances, mechanical properties, tooling and extrusion costs.



A PENNY FOR YOUR THOUGHTS!

ENTRY BLANK

1. One \$2500, one \$1000 and five \$100 awards will be made by Kaiser Aluminum & Chemical Corporation for the extrusion designs submitted and judged to be the first, second and five other best designs submitted. Decision of the judges will be final.
2. All designs submitted must be postmarked before midnight August 31, 1961.
3. Each entry and its subject matter shall be the property of Kaiser Aluminum. Entrants accept these rules when submitting their entries, and agree that Kaiser Aluminum may use the entries in any manner without restriction and without payment or any other obligation to the entrant except to the extent set out in Paragraph 1 above.
4. Contest is open to all persons except employees and families of Kaiser Aluminum & Chemical Corporation, Kaiser Aluminum & Chemical Sales, Inc. and independent extruders.
5. No entry will be accepted unless accompanied by a signed contest entry blank, addressed to:

PENNY FOR YOUR THOUGHTS CONTEST
Kaiser Aluminum & Chemical Corporation
Kaiser Center, Room 847, Oakland 12, California

Signature of Entrant _____

Date _____ Company _____

Title _____ Address _____

City _____ Zone _____ State _____

Additional entry blanks are available from the independent extruder nearest you.



Kaiser Center, Oakland, California

See HONG KONG and MAVERICK weekly,
ABC-TV Network



**OFFICIAL
ENTRY BLANK
MUST ACCOMPANY
ALL ENTRIES**

**Design
an aluminum
extrusion,
win \$2500,
\$1000 or
one of five
\$100 awards.**



No Contest Is Complete Without Clues

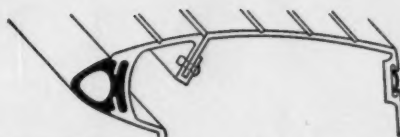
To help you get started on your winning design . . . here are just a few examples of extrusions and the parts they replace.



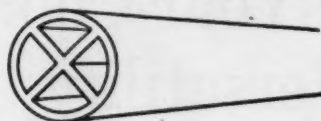
BETTER HEAT TRANSFER . . . The extrusion process makes possible the integral shape shown at right, above. This design provides greater area for heat transfer and minimizes assembly costs.



LOWER WEIGHT, FASTER ASSEMBLY . . . Several different shapes can often be combined into a single extrusion. The integrally stiffened panel above, right, weighs less, reduces joining cost.



GREATER DESIGN FREEDOM . . . This gunwale provides structural strength as well as good appearance. Made as an extrusion, it provides for interlocking, decorative and utilitarian bumpers as well as color strips. No other process allows the styling and low upkeep possibilities found with Aluminum Extrusions. And extrusion dies are inexpensive compared with tooling costs for other types of fabrication. Fasteners are hidden and no welding is necessary.



LESS MACHINING . . . The low inertia hollow rotating member is manufactured from a close tolerance extrusion. It is sawed into sections from a continuous profile rather than from machined castings or bar stock. The extrusion process reduces expensive tooling, scrap and production time.

Now Start Thinking And Designing... It Could Mean Cash For You!

How To Submit Your Winning Entry.

1. All drawings and descriptions must be submitted on white paper no larger than 16" x 20" with the name of your extrusion design and your name and address typed or printed on the upper left corner of each page. Official entry blank must be included.
2. Each design submitted must clearly show the functional purpose of the extrusion.

3. Include a description of your design, its purpose and advantages and any comparisons between the new design and the product or component it might replace.
4. Photographs of existing components, products or your new design may be submitted along with your entry.
5. Contest entries must be postmarked before midnight, August 31, 1961. Winners will be notified by mail before November, 1961.

CONTACT THE INDEPENDENT EXTRUDER NEAREST YOU for expert advice on all extrusion problems or for additional entry blanks.

ARKANSAS			Royce Aluminum, Inc.			Taunton			VA 4-8631			OHIO		
Southern Extrusions, Inc.	Magnolia	CE 4-4260	Trim Alloys, Inc.	Boston					AN 8-5200			Alcoa, Inc.	Akron	BL 3-7701
CALIFORNIA			MICHIGAN									B & T Metals Co.		
The Aluminum Extrusion Co.	Los Angeles	CL 5-1511	Aluminum Extrusions, Inc.	Charlotte	543-2010							Calex Corp.	Columbus	CA 8-5411
American International	San Jose	CY 8-1606	Brazeway, Inc.	Adrian	CO 5-2121							General Extrusions, Inc.	Youngstown	PL 5-9679
B & T Metals Co.	Los Angeles	RA 3-4501	Detroit Gasket & Mfg. Co.	Detroit	KE 1-3400							Magnode Products, Inc.	Trenton	ST 8-9681
Jotaco Extrusions, Inc.	Orange	KE 2-6331	Ferguson Extrusions, Inc.	Detroit	TE 4-5081							National Extrusions & Mfg. Co.	Bellefontaine	YU 8-6331
Kawneer Company	Richmond	BE 2-1821	Light Metals Corp.	Grand Rapids	RI 2-3481							F. A. Pilgrim Co., Inc.	Youngstown	LY 2-9010
Michael Flynn Mfg. Co.	City of Industry	CU 3-6407	Midwest Aluminum Corp.	Kalamazoo	FI 5-8155							Samarar Aluminum Co.	Youngstown	ST 8-4077
Pacific Extrusion, Inc.	Watsonville	PA 4-2244	North American Extrusions Corp.	Kalamazoo	FI 5-8610							F. E. Schumacher Co., Inc.	Hartsville	SW 9-5741
Pax Metal Corp.	Van Nuys	TR 3-2720	Purpose Extruded Aluminum	Hudson	HI 8-2551							Weather-Seal, Inc.	Barberton	TR 7-9307
Texas Aluminum	Mojave	VA 4-4021	Quality Aluminum Products Co.	Coldwater	BR 8-2381							Youngstown Mfg., Inc.	Youngstown	SH 5-2114
FLORIDA			Rogers Industries	Detroit	VE 8-7500							OKLAHOMA		
American International Aluminum Corp.	Miami	NE 4-8591	Valley Metals Products Co.	Plainwell	MU 5-8711							Macklanburg-Duncan Co.	Oklahoma City	JA 8-4411
General Aluminum Fabricators	Miami	TU 7-8231	MISSOURI									PENNSYLVANIA		
Miami Extruders, Inc.	Miami	OX 1-8900										Airmaster	Philadelphia	BA 3-7700
Regal Extrusion Corp.	Miami	NE 3-8128	Hazelwood Engineering & Equipment Co.	Hazelwood (St. Louis)	PE 1-2274							Michael Flynn Mfg. Co.	Philadelphia	FI 2-5500
Ware Laboratories, Inc.	Miami	NE 4-8511	NEW JERSEY									Penn Brass	Erie	TE 8-1931
GEORGIA												Pittsburgh Aluminum Alloys Co.	Pittsburgh	SW 1-4744
Loxscreen Co., Inc.	Chamblee	GL 7-6394	Corson Industries	Delair	NO 2-5500							R. D. Werner Co., Inc.	Greenville	JU 8-8600
ILLINOIS			Midwest Aluminum Corp.	Dayton	DA 9-8113							SOUTH CAROLINA		
Kawneer Company	St. Charles (Chicago)	MA 6-2281	New Jersey Aluminum Extrusions	N. Brunswick	CH 9-6867							Extruded Aluminum Co., Inc.	Summerville	TR 3-2381
Kinthead Industries, Inc.	Chicago	IN 3-7800	Warner Mfg. Corporation	Bloomfield	PI 8-5000							TEXAS		
Mala Extrusions, Inc.	Rock Island	788-9321	NEW YORK									Bauer Aluminum Co.	Dallas	AD 5-2357
Precision Extrusions, Inc.	Bensenville (Chicago)	NA 5-4600	Alan Scott Aluminum	Westbury	ED 4-1800							Texas Aluminum Co., Inc.	Dallas	RI 1-3361
INDIANA			Aywon Wire & Metal Corp.	Brooklyn	TE 9-1000									
Greater Louisville Industries, Inc.	Jeffersonville	BU 2-4341	Badger Aluminum Extrusions	Brooklyn	NI 9-6400									
Mainline Extrusions, Inc.	South Bend	AT 8-9244	Empire Extrusions Corp.	Garden City Park, L. I.	PI 1-6600									
Wells Aluminum Corp.	North Liberty	OL 6-8111	Jari Extrusions, Inc.	E. Rochester	LU 6-2660									
IOWA			Jasco Aluminum Products											
Titus Metals Corp.	Waterloo	AD 4-1771	Div. of Irving Air Chute Co.	New Hyde Park	FI 3-4300									
MASSACHUSETTS			Jerex Corporation	Amityville	MY 1-7270									
Northeast Aluminum, Inc.	Lawrence	MU 3-2718	NORTH CAROLINA											
			Carolina Aluminum Co.	Winton	358-4111									



"New leadership in the world of aluminum"

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

Here's Take-Your-Choice Versatility

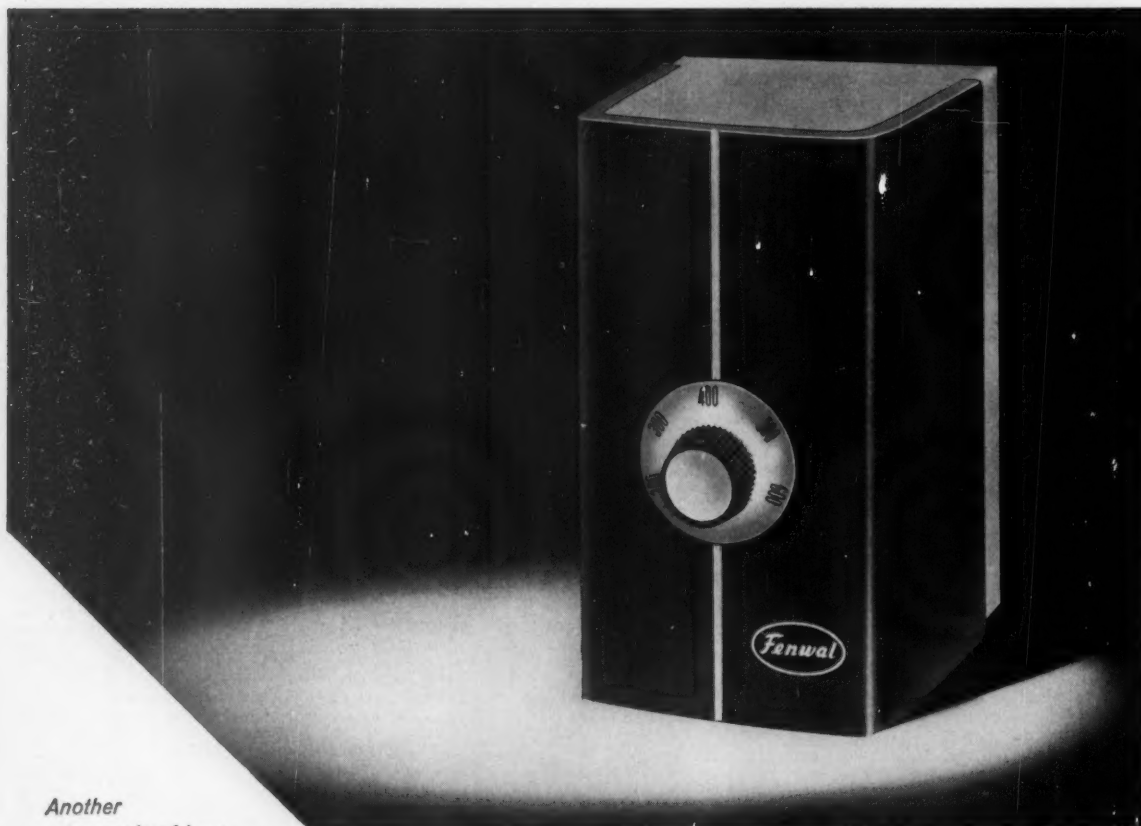
*with the Multi-option Fenwal
536 Temperature Controller*

It's so *precise* and yet so *easily adaptable* to an almost endless variety of temperature control applications, you become all but convinced that the transistorized Model 536 was engineered with only your needs in mind!

From its multi-option printed circuit board to its numerous interchangeable components, the Model 536 Temperature Controller spells *versatility*. ON/OFF or proportioning control . . . dial for set point adjustment mounted externally or internally . . . expanded scales for precise temperature adjustment — the 536 offers all these advantages! Five standard temperature ranges from -50 to $+600^{\circ}\text{F}$. . . separate potentiometer with graduated dial and knob for remote temperature adjustment . . . capacity of 10 amp/110 VAC and 5 amp/230 VAC . . . these choices are also available to you. And you pay only for the options you need!

The 536 is sensitive to within 0.1°F . And if you wish to build a multi-point control and indication system — either gradually or all at one given time — you simply combine the Fenwal Model 580 Temperature Indicator with as many 536 Controllers as you require. Thermistor sensors enable fast response and ordinary copper lead wire may be used for connections. Removable interior of the Model 536 allows easy, safe installation and the instruments are smartly styled to perfectly complement modern industrial machines and interiors.

Find out more about how the precise Model 536 Temperature Controller can be adapted to your exact needs by writing to FENWAL INCORPORATED, 197 Pleasant St., Ashland, Mass. Request Bulletin MC-195.



*Another
example of how*



CONTROLS TEMPERATURE . . . PRECISELY

NO MATTER IF DESIGNS WEIGH
OUNCES
OR
TONS



*... you always have
the right supplier
for any size forgings
when you have
Wyman-Gordon
in mind*

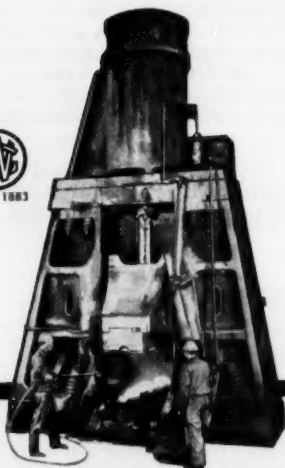
Little reason exists these days for permitting usual "design ceilings" on closed-die forgings—whether in weight, size or configuration—to handicap a product development program. For chances are Wyman-Gordon can lift such limitations entirely from any part planned, or now on your boards.

Your call will bring a seasoned forging specialist who talks forging language—in specific terms of design objectives—and has at his finger tips to help solve your problems the wealth of technical application and product-engineering data amassed by the country's foremost forging organization. Even more, he brings to your design team the latest developments in forging techniques and metallurgical breakthroughs that are substantially extending forging applications in every design dimension.

When you choose Wyman-Gordon you also benefit from the leader's experience in giving your parts optimum metal soundness and physical properties. While these are admittedly generalizations, they have been proven repeatedly in the products of hundreds of top-ranking industrial concerns we serve in every field. Our design assistance—on forgings weighing ounces or tons, produced from any forgeable metal or alloy—can prove as profitable for you as for them.



EST. 1883



WYMAN - GORDON

FORGINGS

of Aluminum Magnesium Steel Titanium ... and Beryllium Molybdenum Columbium and other uncommon materials

HARVEY ILLINOIS

WORCESTER MASSACHUSETTS

DETROIT MICHIGAN

GRAFTON MASSACHUSETTS

LOS ANGELES CALIFORNIA

PALO ALTO CALIFORNIA

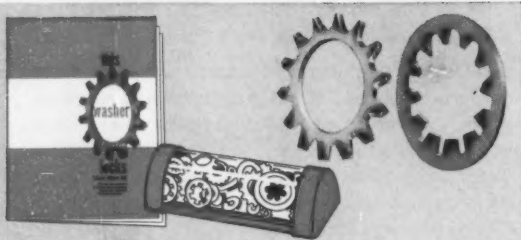
FORT WORTH TEXAS

Circle 258 on Page 19



DON'T GAMBLE . . . with your product's reputation

INSIST ON GENUINE **SHAKEPROOF®**
LIVE ACTION LOCK WASHERS!



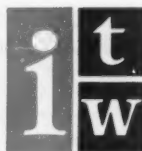
Customer loyalty is not a matter of *luck*! It's based on your product's *reputation* for top quality, trouble-free performance! A good reputation depends on the quality of each component used in manufacture and assembly. Fasteners—lock washers in particular—carry a big part of this responsibility. Washers that don't measure up to the rest of your product can cause real trouble . . . can actually result in brand switching by your customers.

Don't Gamble! Don't settle for a lock washer that's "good enough." Look alikes don't act alike! Genuine Shakeproof Live Action Lock Washers bite on both sides . . . the only lock washers that lock right—stay tight—where others fail.

TEST THE BEST—FREE! Send for the free Shakeproof Live Action Sample Kit. Includes a wide selection of lock washers and the informative "This Washer Locks Where Others Fail" booklet.



Look for this symbol when you buy or specify to be sure you are getting *Genuine* Shakeproof Live Action Lock Washers!



SHAKEPROOF

"FASTENING HEADQUARTERS"
DIVISION OF ILLINOIS TOOL WORKS

St. Charles Road, Elgin, Illinois

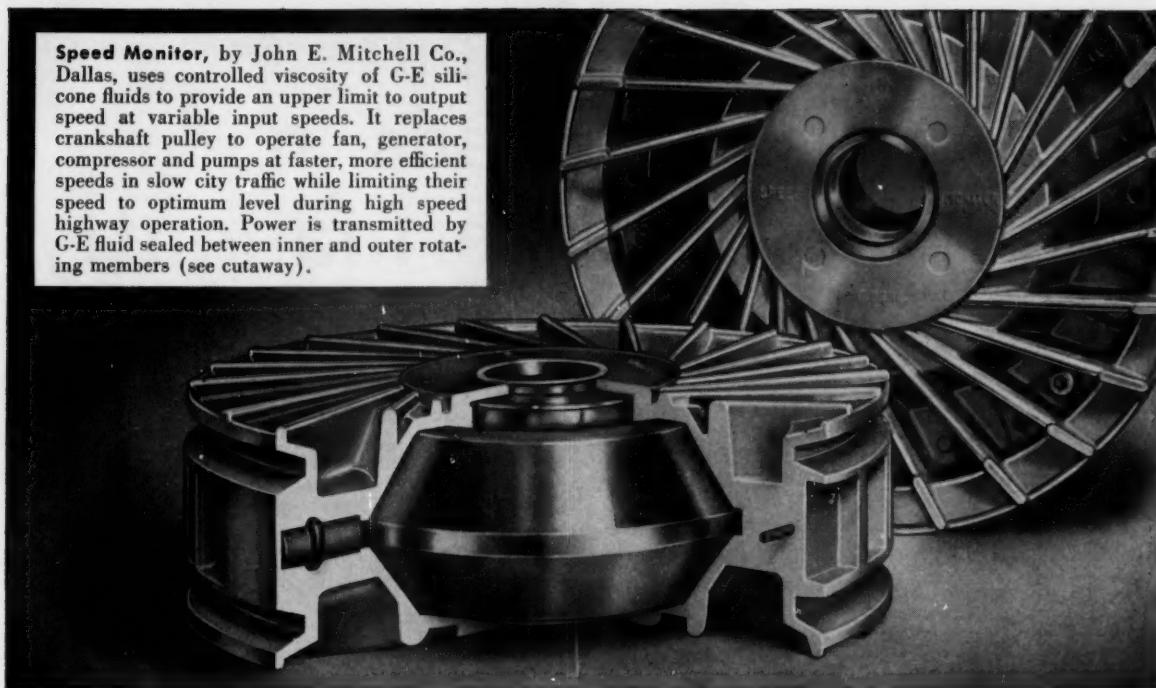
In Canada: SHAKEPROOF/FASTEX, Division of Canada Illinois Tools Ltd.

67 Scarsdale Road, Don Mills, Ontario

Copyright Shakeproof, Division of Illinois Tool Works, 1961

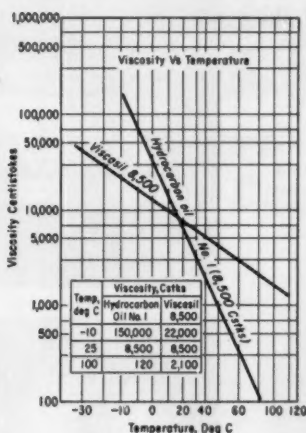
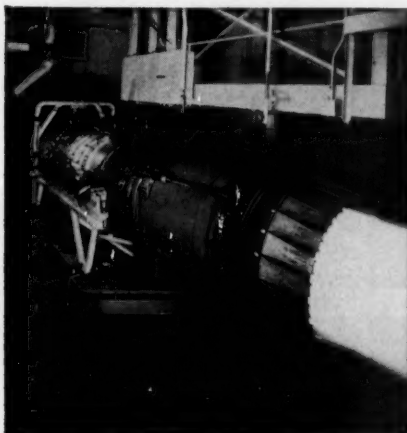
Circle 259 on Page 19

Speed Monitor, by John E. Mitchell Co., Dallas, uses controlled viscosity of G-E silicone fluids to provide an upper limit to output speed at variable input speeds. It replaces crankshaft pulley to operate fan, generator, compressor and pumps at faster, more efficient speeds in slow city traffic while limiting their speed to optimum level during high speed highway operation. Power is transmitted by G-E fluid sealed between inner and outer rotating members (see cutaway).



GENERAL ELECTRIC SILICONE FLUIDS

for reliable performance under tough operating conditions



Thermal stability. The outstanding thermal and oxidative stability of G-E silicone fluids, over an operating temperature range of -100°F to 600°F , makes them suitable for such rigorous applications as jet engine lubricants and aircraft hydraulic fluids. G-E Versilube fluids give unequalled performance at high temperatures and are comparable to other hydraulic fluids in moderate ranges.

Nearly constant viscosity over wide temperature range. G-E silicone fluids exhibit very small changes in viscosity with wide temperature variations. This makes them ideal for many mechanical applications, including fluid drives, dash pots, vibration dampers, timers, shock absorbers, or wherever constant viscosity is needed.

Get the complete story. These bulletins give complete technical data on the G-E silicone fluid line and describe many of the ways in which designers are taking advantage of their outstanding properties. For your free copies, write to Department WW753, General Electric Co., Silicone Products Department, Waterford, N. Y.

GENERAL ELECTRIC

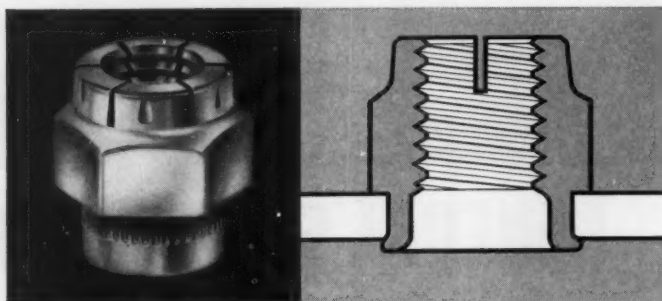
3 quick ways to put load-bearing threads in thin material... permanently!

These SPS 160,000 psi clinch and swage nuts are designed expressly to provide one-piece, all-metal thread wells in thin-section materials of .020 inches and more. Installed with one pressure stroke, they become a permanent, vibration-proof part of your product. No more loose nuts to handle; no need to hold nuts with a wrench while tightening screws. Result: faster, more economical assembly, particularly where it would be awkward to position and hold ordinary nuts. And these same benefits apply to later disassembly and reassembly in the field.

FLEXLOC Self-Locking Clinch Nuts

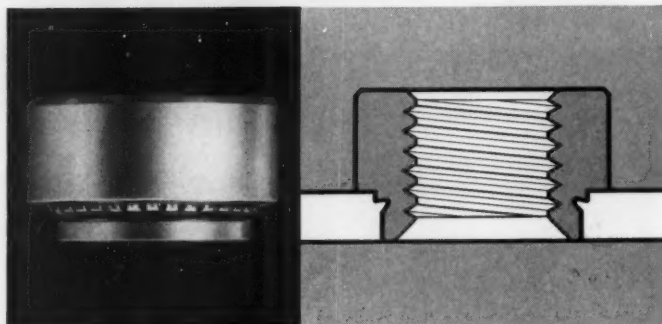
Designed for thin-section materials up to Rockwell C20 hardness. Incorporating the time-proven FLEXLOC self-locking feature, they are specially valuable where equipment must be disassembled periodically. Installed by roll-over clinch method with SPS punch and dolly tips.* Sizes #4 through $\frac{3}{16}$ inch in cadmium-plated steel (serviceable to 550°F), stainless steel (to 800°F), brass and aluminum (to 250°F). Also microsizes—#0 to #4—in same materials. Locking torque and vibration requirements meet or exceed MIL-N-25027.

*Recommended installation tools available as standard products. Dolly tips for flush mounted clinch nuts also available.



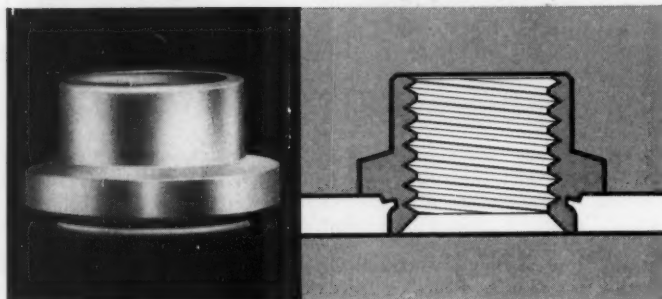
SPS Swage Nuts

The simple, economical solution to the problem of getting sufficient load-bearing threads in thin material. Installed from one side, they mount flush—without use of special tools and without distortion or discoloration of parts. Suitable for materials to Rockwell C25 (this includes mild steels). Good torque-out and push-out values assured by positive displacement of metal into retaining groove. Sizes #2 through $\frac{1}{2}$ inch in cadmium-plated steel. Serviceable to 550°F.



SPS Self-Locking Swage Nuts

Provide flush mounted, self-locking thread element which combines excellent performance with light weight. Installed from one side—with SPS dolly tip—in materials up to Rockwell C27. Push-out and torque-out values, as well as locking torque and vibration requirements, meet or exceed MIL-N-25027. Sizes #2 through $\frac{1}{2}$ inch in cadmium-plated steel. Serviceable to 550°F.



SPS

where reliability replaces probability

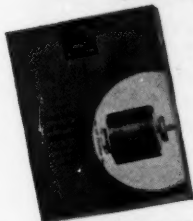
SPS alone offers you this range of one-piece nuts designed specifically for fastening in thin-section materials. And SPS offers them from stock—available for fast delivery through your SPS distributor. Individual bulletins are available on each of these special-purpose SPS nuts—Bulletins #2275 (clinch nuts), #2447 (swage nuts), #2701 (self-locking swage nuts). For copies, write Standard Pressed Steel Co., INDUSTRIAL FASTENER DIVISION, SPS, JENKINTOWN 18, PENNSYLVANIA.



MOTORS

special application

***if special application FHP motors are on your mind...
write for R&M's new Bulletin 445***



This informative bulletin illustrates and describes in detail Robbins & Myers broad new line of Special Application FHP Motors.

You may select from four frame sizes, sixteen ratings from 1/100 through 1/3 HP, three different pole constructions, three standard mounting arrangements and four electrical types.

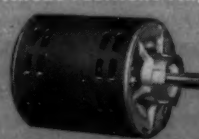
Simple, compact and quiet, these motors offer built-in benefits for your customers, as well as design flexibility for you, where silent operation, limited mounting space and minimum attention are factors.

Also, should your requirements be so special that a custom designed motor is indicated, our expert application engineers, using the most modern electronic computers, can promptly select the optimum design for your special requirements. Write today for your copy of R&M's new bulletin 445-MD

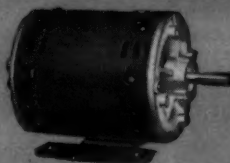
round body
with resilient rings



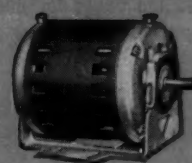
round body
without resilient rings



ratings from 1/100 to 1/3 horsepower



rigid base mounting



resilient base mounting

ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors • Electric Hoists and Overhead Traveling Cranes • Moyno Industrial Pumps
Propellair, Industrial Fans • R & M-Hunter Fans and Electric Heat • Trade-Wind Range Hoods and Ventilators
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.



WHO MAKES GEARMOTORS THIS SMALL?

Globe Industries makes d.c. (and a.c.) gearmotors this small to make your design more compact, reliable and salable. If you need an exact speed-torque combination in a precisely engineered package, look at these 4:

TYPE VS—Motor is $\frac{3}{16}$ " flat, develops .0025 hp @ 8,000 to 17,000 rpm, and can use our standard modular spur gearing in 62 ratios. Continuous duty torques to 35 oz. in. available. Gear box can be side mounted (as shown) or end mounted with a frontal area of only 0.4 square inch.

TYPE SS—a $\frac{7}{16}$ " diameter d.c. motor that develops .004 hp @ 8,000 to 17,000 rpm. Compatible gearing system has 21 planetary ratios or 28 spur gear ratios. Continuous duty torques available to 300 oz. in. Governors, brakes and filters designed to meet MIL specs also.

TYPE MM & LL—Most widely used $1\frac{1}{4}$ " diameter pre-

cision miniature motors and gearmotors in the world. Choose from 101 standard planetary ratios; torques to 1000 oz. in. Because these and other Globe motors have many standard armature windings, it's easy to get the exact speed-torque combination you need. Motors to .015 hp @ 6,000 to 15,000 rpm.

TYPE BD & BL— $1\frac{1}{2}$ " diameter d.c. motors with planetary gearing in 22 ratios. Unit illustrated provides up to 100 in. lb. continuous duty. With a 3" final stage, continuous duty torques to 500 in. lb. (1000 in. lb. intermittent) are available. These can replace units 5 times their size and weight. Motors to .033 hp @ 4,000 to 10,000 rpm.

Delivery is prompt; cost is reasonable. For details about d.c. and a.c. gearmotors request bulletin GGM from Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio.

GLOBE INDUSTRIES, INC.

PRECISION MINIATURE MOTORS, GEARMOTORS, TIMERS,
ACTUATORS, CLUTCHES, BLOWERS, MOTORIZED DEVICES

GLOBE



Dow Corning

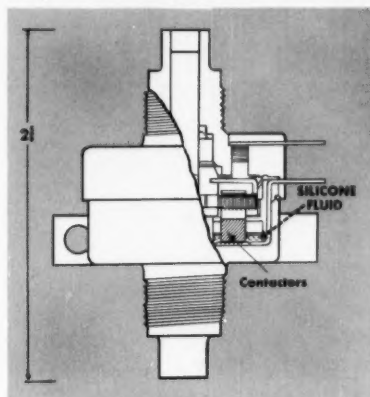
SILICONE NEWS

for design and development engineers • No. 84

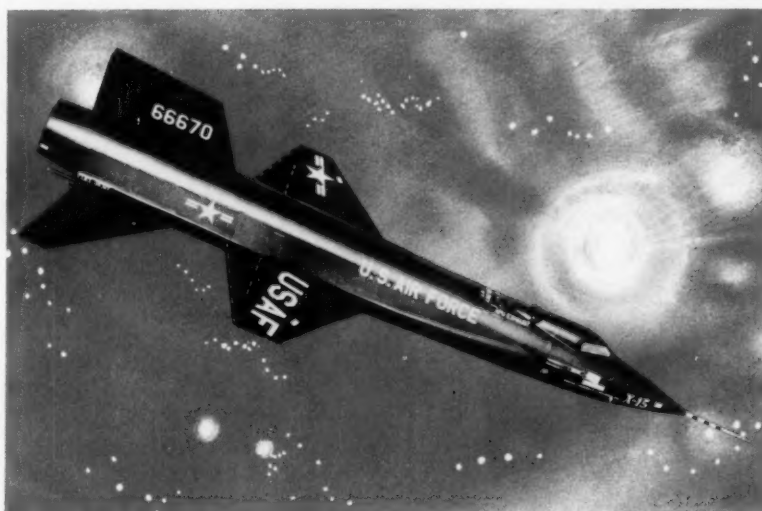
SLO-O-W MOTION

To sense extremely slow motion — or lack of motion — requires a detector that retains uniform sensitivity despite fluctuations in ambient temperatures. And that means silicones according to the designers who engineered the Micro Motion Detector manufactured by Gaylord Controls, Division of Gaylord Products Inc., Chicago. Here's how they describe this super-sensitive unit.

"Detection of motion is accomplished by a set of equally spaced hydrodynamically responsive electrical contactors driven by a common shaft. When driven at or above



a fixed speed, the contactors plane on the surface of a pool of Dow Corning silicone fluid. When shaft speed is (Cont. Pg. 2)



Probing Space At 3600 MPH

The X-15 provides a testing ground for both men and materials preparing for manned space flights. One of the successful materials is Silastic® LS, the Dow Corning fluorosilicone rubber that helps simplify designs because of its exceptional resistance to fuels, oils and solvents.

Engineers of Reaction Motors Division of Thiokol Chemical Corporation specified an accumulator diaphragm of Silastic LS

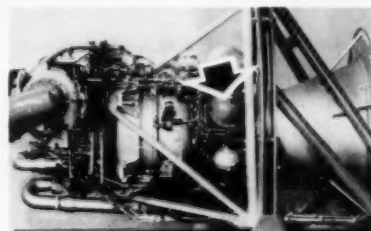
for the X-15's XLR-99 engine. The accumulator provides oil at a constant pressure to the lube oil pump. Gaseous nitrogen under pressure is the source of stored energy, and is separated from 4-11V Halocarbon oil by the Silastic LS.

Here are diaphragm requirements the designers established as essential: An elastomer that—

1. is flexible from -80 to 200 F;
2. is compatible with the lube oil at low and elevated temperatures;
3. will not contaminate lube oil.

Silastic LS . . . the only elastomer to meet all these requirements . . . helps the X-15 as it knocks on the door to outer space.

Shown below is the XLR-99 rocket engine. The lube oil accumulator is the light weight type . . . made possible by the diaphragm of Silastic LS . . . instead of the heavy, bulky piston type. Parts of Silastic can be engineered to meet your specific needs by your rubber fabricator. For more information about oil and solvent resistant Silastic parts, circle No. 241

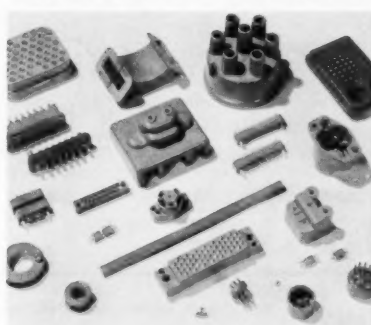


700 F PARTS MADE EASY

A new, thermosetting silicone compound that forms easily into rigid parts capable of 700 F service is now obtainable from Dow Corning. Designated M-6-4156, the new material makes possible high accuracy, low cost parts that are capable of withstanding exceptionally rigorous service.

Using this mineral-filled silicone molding compound, fabricators can mold parts directly into finished shapes, without costly machining. Finished parts exhibit outstanding characteristics:

- long-term dimensional stability at 700 F;
- excellent resistance to thermal shock; (from -67 to 500 F)
- low dissipation factor of 0.002 at 10⁶ cps;
- high arc resistance, over 400 seconds.

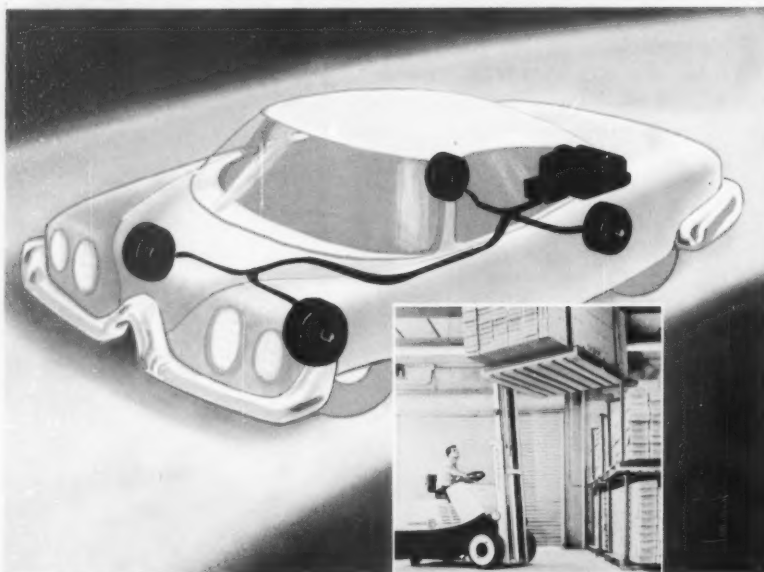


Suggested applications include: fuses and fuse holders, coil forms, relay parts, tube bases, terminal parts, contactors, arc barriers, tube sockets, switch parts, and other close-tolerance ceramic parts.

Fabricators report this new (Cont. Pg. 2)

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE OR REFERENCE NUMBER ON READER SERVICE CARD

MORE



Electric Autos, How Soon?

Another significant straw in the wind of what may be in store for American automobile owners is presaged by introduction of a new line of electrically-driven fork lift trucks by Automatic Transportation Company, Chicago.

Current for the traction motors driving these materials handling trucks is supplied by a variable voltage generator powered by a gasoline engine. The synchronized power package supplies fast, smooth pick-up at the touch of the accelerator. The trucks are capable of traveling 8.5 m.p.h. . . . will start or stop on 28% ramps when fully loaded.

Electric propulsion has eliminated the need for a clutch, fluid coupling, fluid torque converter or multiple speed transmission. Result — lower operating costs, increased efficiency, less maintenance and potentially fewer costly repairs.

SILICONE COMPOUND (Cont.)

Dow Corning silicone molding compound is exceptionally easy to use. Even complex and intricate shapes are quickly and

Automatic engineers place their reliance on traction motors insulated with Dow Corning Silicones because they provide greater power-per-pound and greater reliability than drives insulated with any other material. Silicone insulation provides a more generous service factor (for reliability) than is possible with any other insulating material.

If you can use more power in a smaller package, or increased efficiency with the ultimate in dependable operation, you should be looking into silicone insulated motors. Drives insulated with silicones are already at the forefront in the development of new traction motors for trucks, earth moving machines, materials handling equipment, mining machinery and locomotives. Perhaps, one day, the family car will head the list! No. 242

economically fabricated using established techniques with conventional compression or transfer molding equipment. For more information, circle No. 243

new literature on silicones

ALL NEW BROCHURE describes how Syl-off (silicone) coated papers save time and money for packagers and users of sticky products. Illustrates applications as package liners, process papers, interleaving and slip sheets. Also includes samples of coated papers plus listing of approved sources for paper products made with Syl-off coatings. No. 245

FIRST AVAILABILITY! "How Silicones Aid the Rubber Industry" is a production-engineering guide to the Dow Corning Silicones most useful in producing rubber and plastic materials and parts. This new eight-page manual is a concise, comprehensive reference to the ways silicones keep production on schedule, make better products, minimize scrap, speed handling and reduce maintenance and downtime. No. 246

Silicone Adhesives Really Stick . . . Anywhere! From -80 to 500 F, pressure-sensitive silicone adhesives withstand moisture, oxidation, weathering, corrosive chemicals, arcing, corona, and fungus; have excellent dielectric strength. Excellent for use on tapes, as sealants, spray-on coatings, bonding materials and splicing agents. No. 247

SILICONE FLUID (Continued)

reduced, the contactors break through the fluid medium and make electrical contact with the terminal plate. When shaft speed is increased the contactors emerge through the fluid and contact is broken.

"If deceleration is at a slow rate, the contact closes at approximately zero RPM; if extremely rapid, as with a brake, contact is made a fraction of a second after zero shaft speed is reached. When the shaft is accelerated slowly, the contact opens at about 8 RPM; accelerated at a higher rate, the contact opens instantaneously."

From this description, it is quite obvious that the fluid medium must retain near-uniform viscosity over wide temperature ranges, must be oxidation-resistant, non-gumming, and must withstand shear without viscosity breakdown. That's why Gaylord engineers specified Dow Corning silicone fluid.

For detailed information on properties and applications, circle No. 244

Dow Corning Corporation, Dept. 6919, Midland, Michigan
Please send me: 241 242 243 244 245
246 247

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MIDLAND, MICHIGAN

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"Dayton Cog-Belt"® is doing a job

You see here a unique, unusually efficient V-Belt Drive . . . typical of the quality engineering which has made Jacobsen Manufacturing Company a leader in the power mower field since 1921.

Severe Drive Problems. Only trouble is, in *this* unit—a powerful 26 inch rotary mower—the efficient design also puts unusual demands on the belt drive system. Note, for example, the sharp reverse bend . . . the short, severe quarter-twist. Also realize that the drive, operating in a metal housing from 4¼ hp motor to high-speed cutter blade, is subjected to severe heat from the motor sheave.

Wrapped Belts Fail. The problem of belt life used to be so severe that Jacobsen engineers couldn't keep a standard wrapped covered belt on

the drive long enough to make any realistic tests! According to Sherman Heth, vice president in charge of engineering for Jacobsen, "The back-side idler caused the bottom side of a wrapped belt to crack. Also, the belt, because of the half-twist between motor and backside idler, would fight out of the sheave grooves. And heat plus shock loads would quickly deteriorate it.

Dayton Solves The Problem. "Then we tried the Dayton Cog-Belt. The Dayton Cog-Belt was unaffected by the heat! It has no cover, hence it didn't crack. Its cogs provide great flexibility, keep it tracking in the sheave grooves. The problem was solved! The Dayton Cog-Belt did then—and still is doing—what no other standard-type V-Belt could! We've had virtually no troubles, and the drive has worked well in the thousands of these mowers sold since!"



Powerful, easy-to-handle Jacobsen's popular 26-inch "Javelin" mows an acre an hour, travels uphill and down at speeds up to 5 mph. This powerful rotary mower can also pull a three-gang reel, a cart, roller, sweeper, or fertilizer spreader.



Jacobsen Vice President Sherman Heth (center) discusses the efficient, compact drive features of the Jacobsen "Javelin" with Tom Farrell, Dayton regional manager (left) and Bob Schreiber, Dayton sales engineer.

Drive Engineering Service. Perhaps the Dayton Cog-Belt can help solve your drive problems, too. A Dayton sales engineer will be glad to work with you. Phone or write us direct. Remember: **ONLY DAYTON MAKES THE COG-BELT.**

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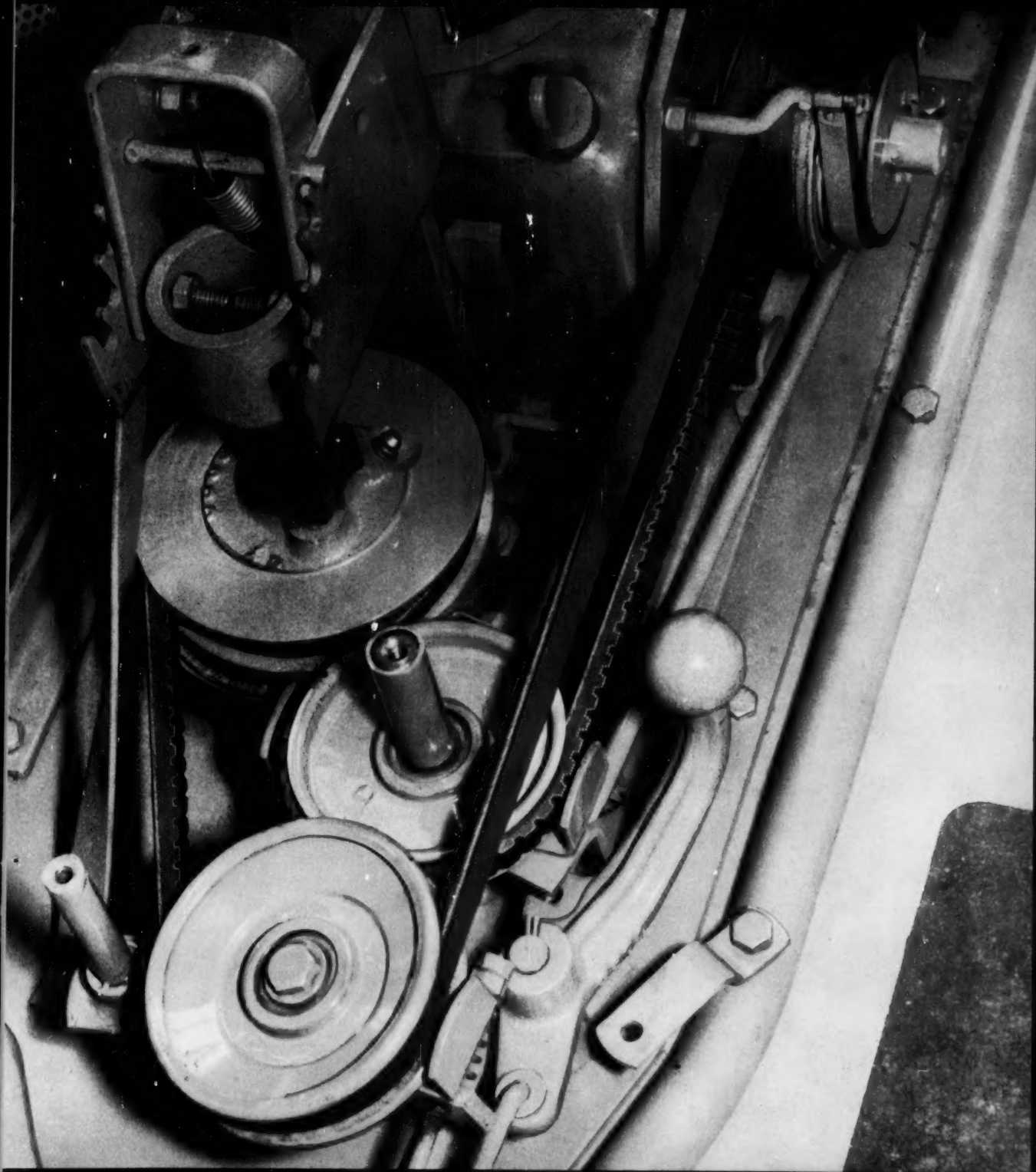
Dayco
CORPORATION



Dayton Industrial Products Co. Div.

Melrose Park, Illinois

no other standard V-Belt could"



Jacobsen's unique motor-to-cutter drive requires the Dayton Cog-Belt to make a short severe twist and reverse bend between 3" motor sheave and 3½" backside idler, and operate at high speeds under often-intense heat and abrupt shock.



What's new in drafting materials? Get it firsthand from Dietzgen

Today's engineering and production achievements are miracles of teamwork. The talents of scores, hundreds and even thousands of engineers, architects, technicians, draftsmen, and specialists are coordinated through rapid and accurate interchange of ideas. Technical drawings are the primary communication media of this progress and their preparation represents approximately 70% of the total engineering costs.

Dietzgen's long experience and continuing research plays an important part in providing new techniques, materials, and equipment to boost drafting room efficiencies. For example: Dietzgen "no-print" gridded drafting media promote faster, more accurate sketch work and eliminate many tedious re-drawing operations. New Dietzgen sensitized drafting media have pioneered such time-saving cost-cutting techniques as template drafting, registration drafting, and new methods for retrieving drawings which have lost their line density.

No organization can afford to ignore the advantages and economies these new drafting media provide. Now is the time to try, test and prove the value of Dietzgen drafting materials in your engineering-drafting departments.

Write today for the new Drafting Media brochure. This 28-page booklet not only presents what's new in drafting materials, it also explains and illustrates their many uses. Address your request on your company letterhead and ask for Publication MKTG3-G-160.

EUGENE DIETZGEN CO. Chicago 14, Illinois.

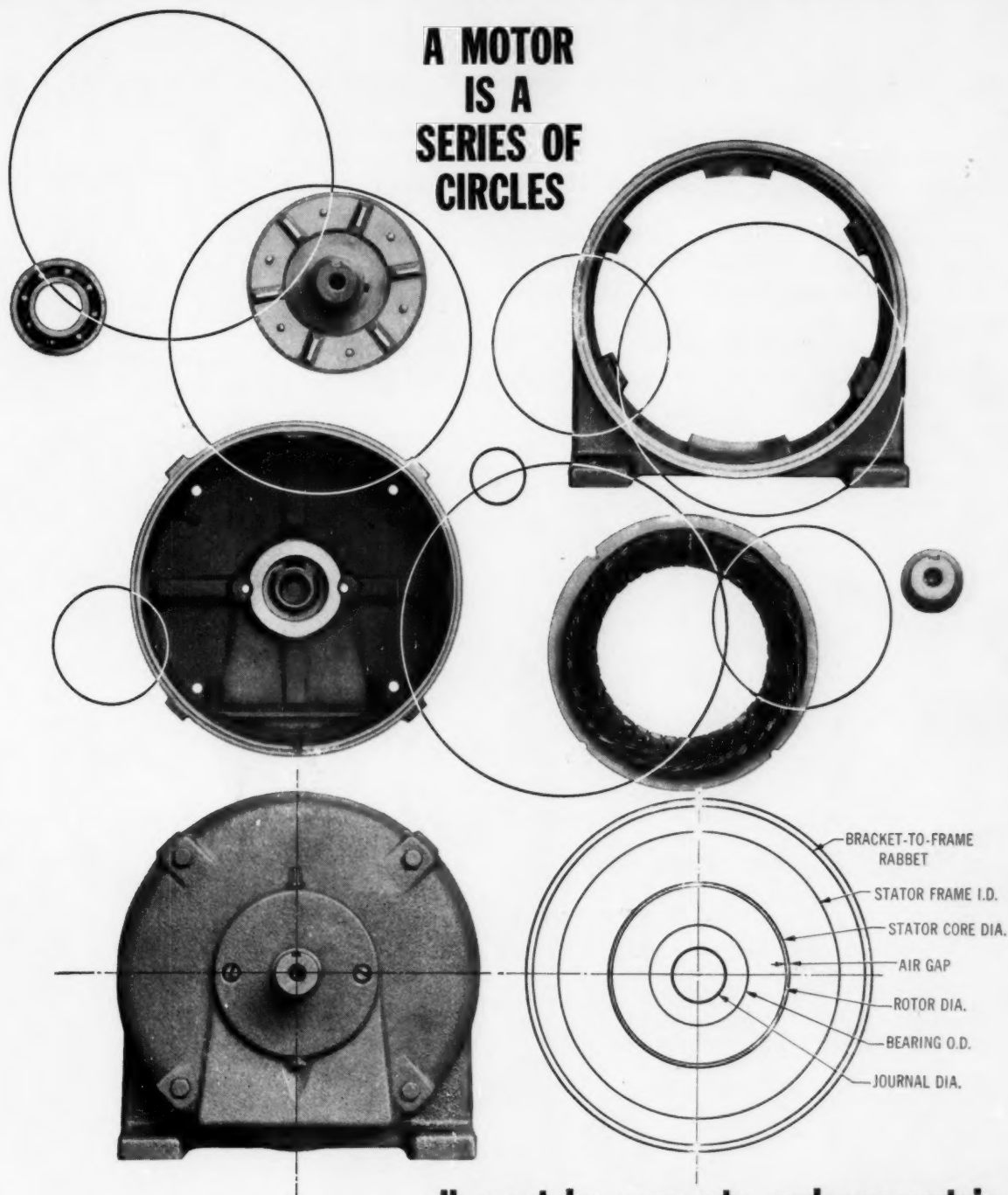
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A MOTOR IS A SERIES OF CIRCLES



all must be accurate and concentric

In manufacturing Elliott Crocker-Wheeler motors, a dozen critical "circles" are formed accurately and concentrically through unique and extraordinarily precise production methods. The result is exact alignment of all parts, true and uniform air gap, free-spinning rotor, quiet, cool, dependable operation.

■ Elliott Crocker-Wheeler integral-hp a-c and d-c motors—from smallest to largest—are offered in all conventional enclosures and modifications; with insulation to suit the application, including **EPAOSEAL** epoxy insulation for use where conditions are most severe.

WI-3

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Malleable Puts More Muscle in Machinery

In the agricultural equipment field, reputations depend on building products that can take rough treatment . . . and give real value. To do it, agricultural equipment manufacturers rely heavily on Malleable iron castings.

Malleable's excellent ductility and shock resistance mean longer life and fewer problems than obtainable with fabrications. Low start-up cost for small quantities also is vitally important in this competitive industry.

Put more reputation-building quality into your products at less cost with Malleable. For design assistance or quotations, call any company that displays this symbol —



PROBLEM-SOLVING IDEAS are yours free in Data Unit No. 115. For your copy, ask any member of the Malleable Castings Council, or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

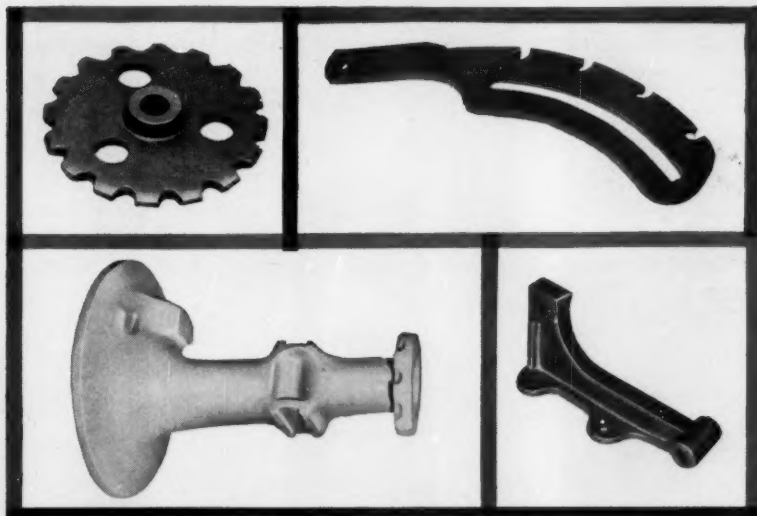
MEMBER



The versatility of Malleable castings is reflected in the variety of ferritic and pearlitic Malleable tractor parts, from the tough, dependable front axle bar to bolsters, lift arms, clamps, clevises, hitches, hinges, foot pedals, transmission planetary carriers and clutch parts.

No machining or hardening is required on this Malleable chain sprocket. It replaces a part cut from steel plate to which a hub was welded. Cost was reduced 12%. Tests verified the excellent performance of the malleable part, and led to a review of the company's entire manufacture of chain sprockets.

Field failures stopped as soon as the manufacturer of this plow quadrant began using a Malleable casting in place of a welded fabrication. This part looks better, works better, and quality is uniform in every piece. Yet the Malleable quadrant costs 22% less than the fabrication.



The strength of Malleable is illustrated by farm tractor rear axle housings. They must absorb the constant shock and strain exerted as heavy implements are dragged over rough fields. Toughness, ease of machining and economy make Malleable first choice for this demanding application.

Costs dropped 59% when this disc harrow ram anchor was converted from a weldment to a Malleable casting. Malleable's shock resistance combined with a better design resulted in a part able to withstand constant punishment.



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MALLEABLE

For Service Contact...

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Chicago Malleable Castings Co., Chicago 43
Moline Iron Works, Moline
Moline Malleable Iron Co., St. Charles
National Malleable and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA

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Laconia Malleable Iron Co., Laconia

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Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS

Texas Foundries, Inc., Lufkin

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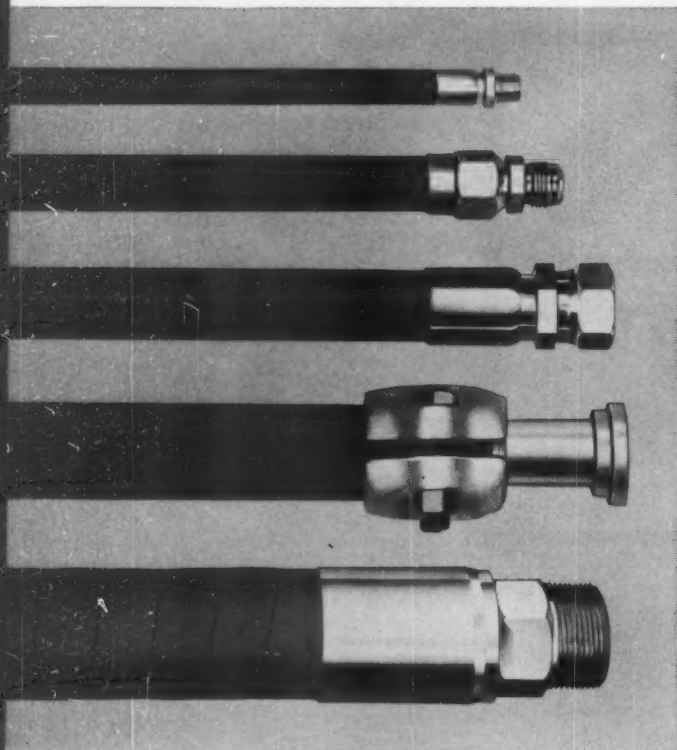
West Virginia Malleable Iron Co., Point Pleasant

WISCONSIN

Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsch Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
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**These companies are members
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WHAT'S NEW IN HYDRAULIC ASK...IMPERIAL-

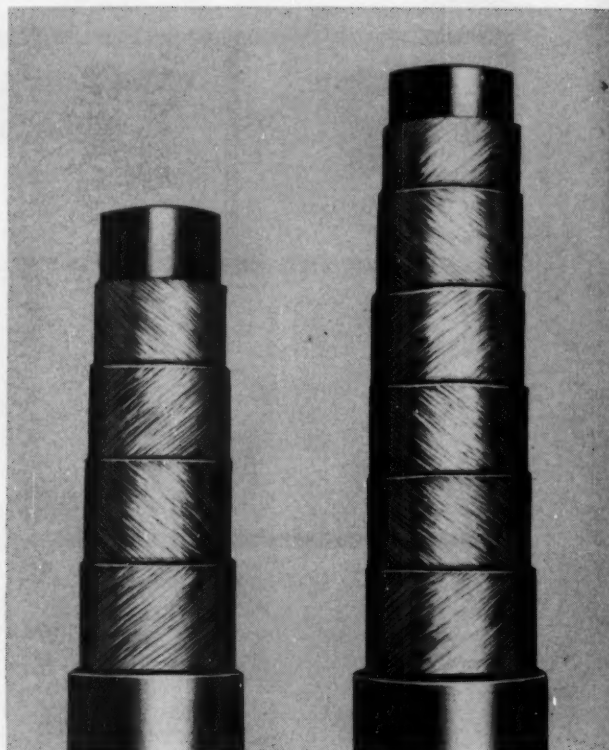


NEW EXPANDED LINE

With the addition of new products, particularly in higher pressure hose assemblies, the Imperial-Eastman line offers more than you will find elsewhere. Here's a complete line of wire braid hose, as well as Imperial-Eastman's new Hytron polyamide-polyester hose. Medium-pressure hose assemblies now include 2-spiral wire and 1-wire braid. High and super-high assemblies are available to meet working pressures to 11,000 psi. Couplings, adapters, adapter unions, fittings—we have them to meet all your needs.



*Ask for free literature
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NEW HIGHER PRESSURE ASSEMBLIES

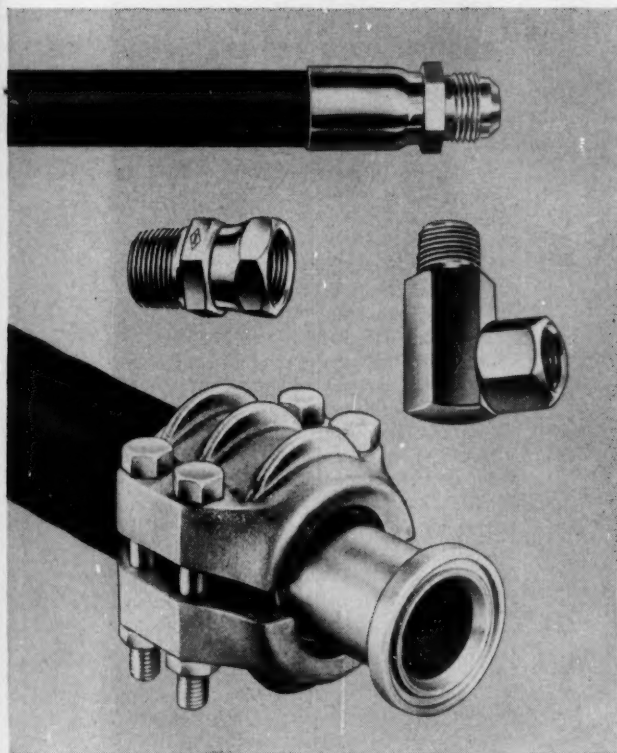
Working-pressure requirements going up for you? Then look for problem solutions at Imperial-Eastman. Hose assemblies are now available in the high- and ultra-high-pressure ranges—up to 11,000 psi. Again, the completeness of the Imperial-Eastman line and the engineered, tested quality offer advantages you won't find elsewhere. Among I-E's new products is a 6-spiral hose now available in sizes from 1/4 to 2 in.—to withstand working pressures up to 11,000 psi. Other constructions withstand working pressures in excess of 3000 psi.

IMPERIAL

Imperial-Eastman Corporation General Offices:
Imperial-Eastman Corporation (Canada) Ltd.,
Barrie, Ontario

HOSE ASSEMBLIES? EASTMAN

New ideas, new research, new products plus an expanded line of hydraulic hose assemblies—these are developments now coming from Imperial-Eastman. It's a complete line—includes low- to ultra-high-pressure assemblies to meet your expanding needs. As always, the line reflects highest engineering and manufacturing standards.



NEW MATCHED-QUALITY COUPLINGS

You know that hose assemblies deliver best service with the proper application of couplings and fittings. From Imperial-Eastman you get matched quality in the complete assembly—with permanent or reusable couplings—and with adapters, adapter unions and other connectors. Now available is a new 4-bolt, clamp-type coupling to withstand working pressures to 2500 psi in the 2 in. size. Factory-assembled permanent couplings are applied by an exclusive I-E pressure-controlled process to assure absolute, matched-quality dependability.



NEW HYTRON® HOSE

This new polyamide-polyester hose solves many problems, meets many specifications as an alternative to one-wire braid SAE 100R1 hose. It has seven times the flex impulse life of wire braid, with comparable strength. Hytron hose also features excellent compatibility with mineral or synthetic fluids having either phosphate ester or water bases. Withstands burst pressures from 9000 to 12,000 psi—temperatures from -45° to 250° F. Hytron is available in long lengths—to 1000'; furnished with permanent or reusable couplings.

EASTMAN

6300 West Howard Street, Chicago 48, Illinois
Imperial-Eastman, S.A., Apartado Postal 26544,
Mexico 13, D.F.

Circle 269 on Page 19



Imperial-Eastman Corporation, 6300 W. Howard St., Chicago 48, Ill.

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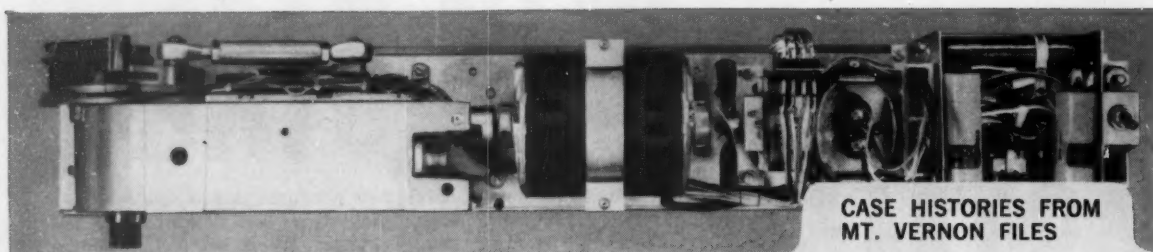
- ☐ The complete Imperial-Eastman line of assemblies
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CASE HISTORIES FROM
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The STANLEY® MAGIC-DOOR Electric Operator . . .

another open and shut case
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From Stanley* comes this new electric, automatic door opener, compact and economically priced and amply powered to handle all new or existing doors up to 42" widths—weights up to 150 lbs.

The Operator, a compact power package, measures only 5½" x 6" x 31"—weighs less than 40 lbs.—contains 5 major assemblies including a transmission which is the muscle. Although the transmission case is somewhat smaller than an ordinary shoe box, it contains all the gears, cams, bearings, linkages, etc. for converting the high speed output of the motor into a mighty and instantly responsive door-swinging thrust.

Shown here are the 5 Mt. Vernon die castings which make up the transmission case—3 cover plates—1 bridge plate and 1 main housing.

Your practised eye will tell you that the latter is a very complex casting—a compact casting designed with enormous built-in strength to meet its service load strains.

Producing castings of this nature is never easy—but rarely a problem at Mt. Vernon for we offer manufacturers more than die casting production. Ours is a four-fold service • designing, die making, casting and machining • a coordinated service—all under one roof in 200,000 sq. ft. of space. The most advanced independent die casting plant in the country.

Complex or simple, why not bring your die casting problems to us. What we do for Stanley and others we can surely do for you. Just call your nearest Mt. Vernon Field Salesman or our home office.

*The Stanley Works, New Britain, Conn.



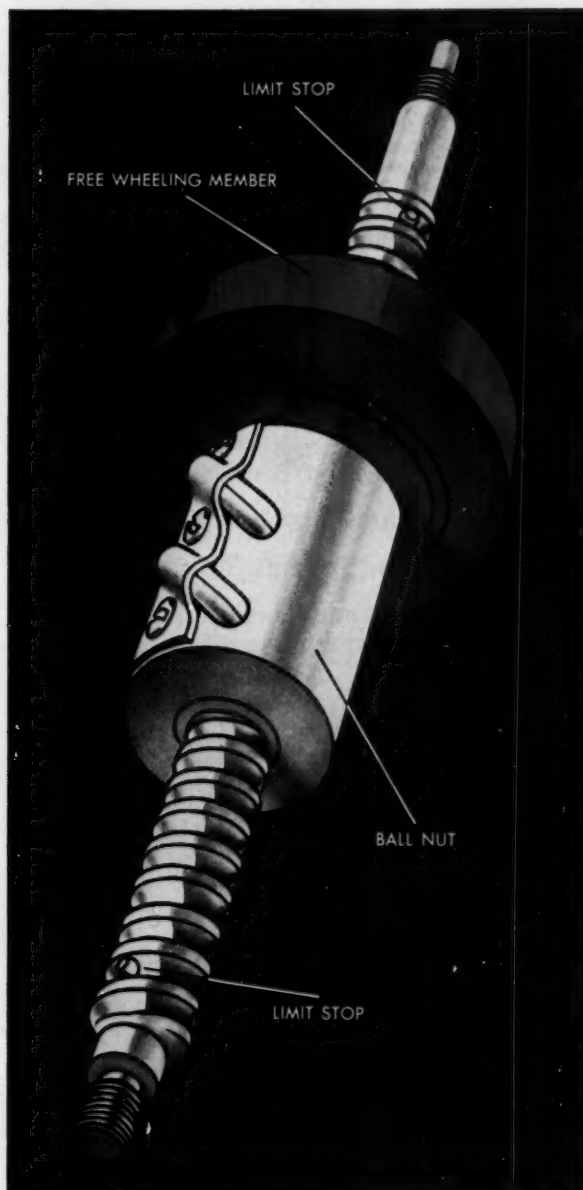
MT. VERNON DIE CASTING CORPORATION

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An Entirely New Design Concept For the Actuation Engineer!



SAGINAW b/b SCREW WITH TORQUE LIMITER FREE WHEELS AT BOTH ENDS OF ACTUATOR STROKE

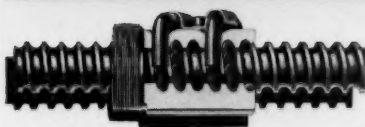
With the introduction of the Torque Limiter for Saginaw Ball Bearing Screws, actuator design has made a significant step forward. That's because the Torque Limiter permits b/b screws to free wheel at both ends of the actuator stroke at normal loads.

Designed to overcome load limitations common to conventional free wheeling b/b screws, the Torque Limiter may be used with any size Saginaw b/b Screw. The only load limitation is the design capability of the basic screw.

Integral stops on the screw shaft precisely control the length of the stroke. When the ball nut reaches either stop, it free wheels. The drive energy is absorbed by the Torque Limiter. Loading may be tension, compression, or a combination of both.

Some areas in which Saginaw b/b Screws with the Torque Limiter can be used are: *Overload Protection* for motors when the actuator reaches travel limits; *Overtravel Protection* in case limit switches fail to stop drive; *Exact Positioning* without other complex positioning systems due to integral stops; *Holding Devices* where drive continues to operate at end of actuator stroke until reversed to release; *Forward-Stop-Reverse Systems* where motors can be smaller and less expensive since instantaneous reversing at drive limits is not required; *Stepless Actuation* for precise, controlled positioning with repeatable accuracy . . . an inherent advantage of all Saginaw b/b screw actuators.

If you have an actuator design problem, we will be happy to help you find the solution. Write, Chief Applications Engineer, b/b Screw and Spline Operation, Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Michigan.



WRITE FOR NEW DATA BOOK

Saginaw  **Screw**

Reliance develops first line of solid state regulators for variable speed drives

**... gives you better circuits,
precise control, less maintenance.**

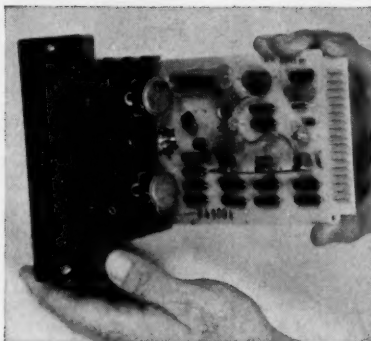
Reliance has produced the first complete line of solid state regulators and exciters for variable speed (V•S) drives and Engineered Drive Systems. These new devices, using power silicon rectifiers and diodes in place of tubes, achieve precise motor control, 1/10% regulation at base speed, with response times up to twice as fast as tube-type regulators. Here is a major advance in variable speed control, and a major advantage for the industrial user. Reliance Drives with these new regulators are now available to you in 1 to 1500 horsepower.

Reliance research and development brings you a more efficient drive than ever before ... and a notable refinement of already well-engineered systems.

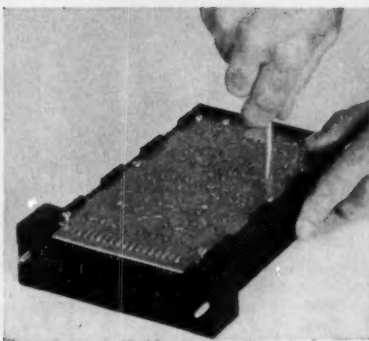
The pictures on the facing page tell the story.



RELIANCE...builders of the tools of automation



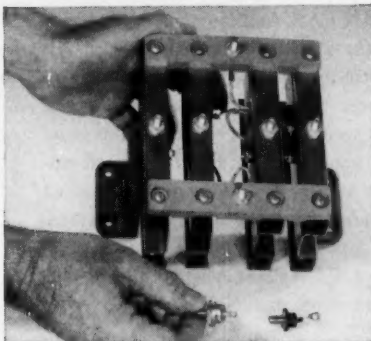
1. Heart of the system is new "Cardpak" control circuit, with transistors, capacitors and resistors to amplify feed-back signals.



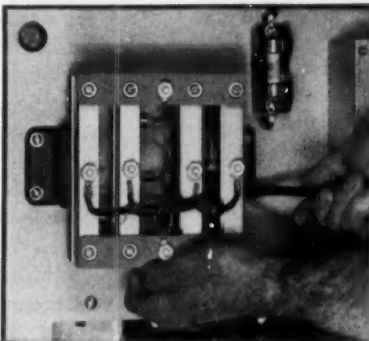
2. Each plug-in "Cardpak" module is a complete control circuit...can be quickly checked and easily replaced, if ever necessary.



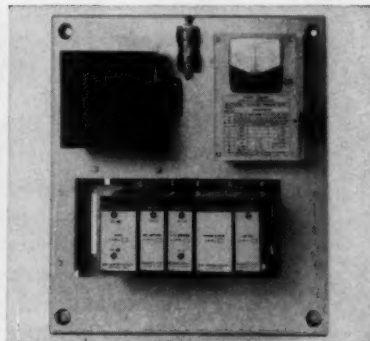
3. Each V*S Drive control system is tailored to your specific job... with "Cardpak" circuits pre-engineered for reliability, fast delivery.



4. Power silicon controlled rectifiers and diodes, instead of tubes, are among the most reliable components yet devised.



5. The rectifiers, mounted on copper plates for heat radiation, operate over a wide temperature range with no special cooling.



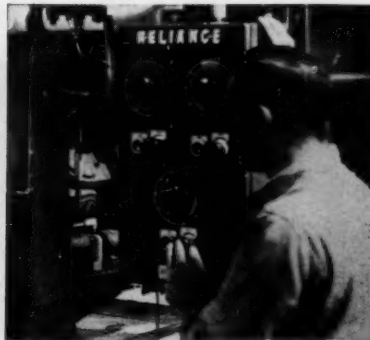
6. Complete panel can be checked quickly for start-up and trouble shooting with the optional test fixture... one meter, one knob.



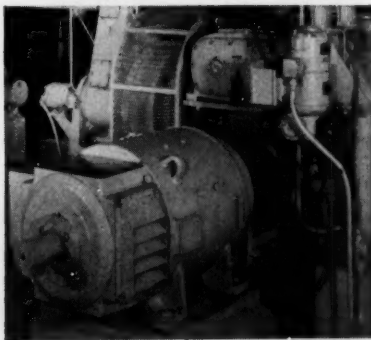
7. Motor control is precise... 1/10% regulation at base speed, with response times up to twice as fast as tube type regulators.



8. The Reliance V*S Drive control cabinet is 35% smaller than conventional drives. Cabinet can be located where convenient.



9. Operator's station centralizes drive operation. Multiple stations, bench boards, pendant stations and special controls available.



10. The Super-T D-c. Motor... integral part of the V*S Drive. It's rugged... absorbs repeated 100% overloads for one full minute.

Your nearest Reliance Systems Engineer will give you all the facts... help you apply Reliance V*S Drives to your products and processes. Call him through the Yellow Pages, or write us direct.

A-1089

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 28-7, CLEVELAND 17, OHIO • Canadian Division: Toronto, Ont.

GRAPHITAR[®]

(CARBON·GRAPHITE)

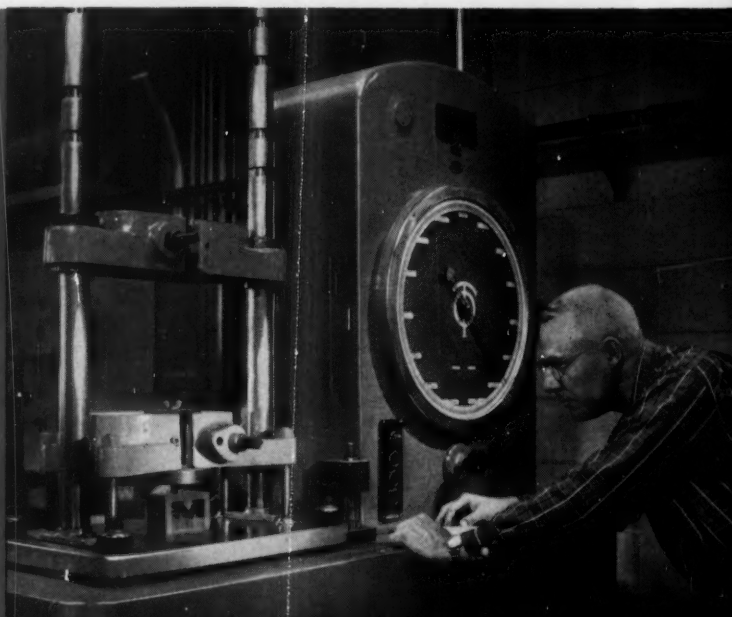
FOR PERFORMANCE

Superior performance and unusually long service life, even in tough applications, is practically second nature to parts made of GRAPHITAR. That's because they combine GRAPHITAR's chemical stability, heat resistance, low coefficient of friction, adaptability to self-lubrication, mechanical strength, hardness and light weight. An everyday application of GRAPHITAR that illustrates well its versatility and remarkable performance can be found in the face-type valves employed in bulk station gasoline meters.

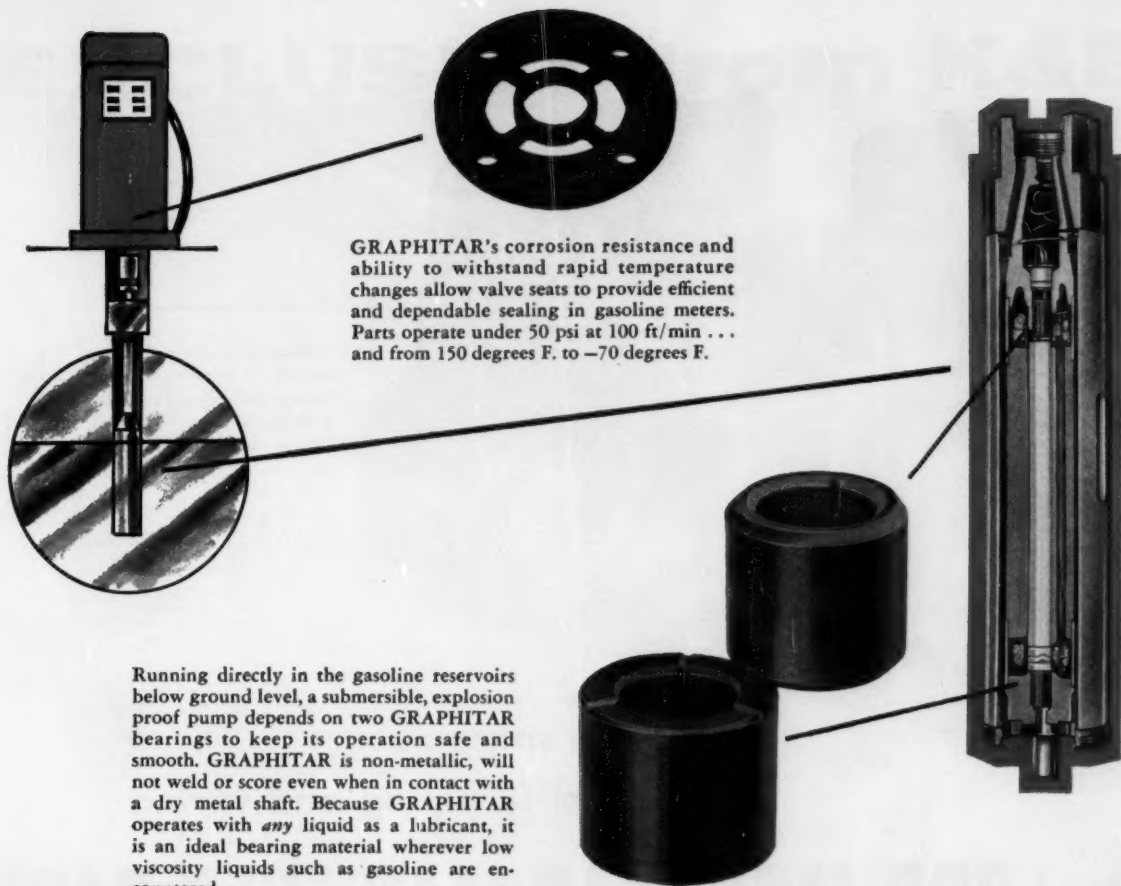
These valves incorporate GRAPHITAR seats. Here, GRAPHITAR's corrosion resistance, chemical inertness and resistance to expansion or contraction under rapid temperature changes, allow the valves to provide a leak-tight seal with excellent wear characteristics. These same characteristics are necessary for good performance wherever steam, gas and chemicals must be handled under the most adverse conditions. Perhaps your product can benefit from the top performance of GRAPHITAR, a unique and versatile engineering material.



Comparative testing of various grades of GRAPHITAR self-aligning seals is accomplished on this equipment, which duplicates actual operating conditions. GRAPHITAR rotary pressure joint seals such as these often operate at 400 psi, at 650°F. and at rotary speeds of 600 ft/min.

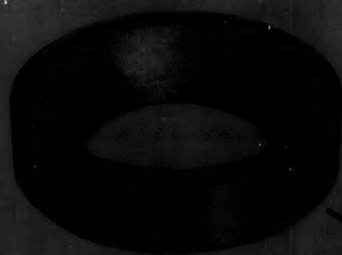


Tests show that the compressive strength of GRAPHITAR grades varies from 4,500 to 45,000 psi. Correct part design can take advantage of this desirable characteristic to aid part performance.

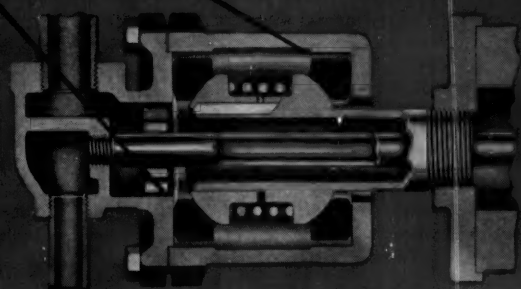


GRAPHITAR's corrosion resistance and ability to withstand rapid temperature changes allow valve seats to provide efficient and dependable sealing in gasoline meters. Parts operate under 50 psi at 100 ft/min . . . and from 150 degrees F. to -70 degrees F.

Running directly in the gasoline reservoirs below ground level, a submersible, explosion proof pump depends on two GRAPHITAR bearings to keep its operation safe and smooth. GRAPHITAR is non-metallic, will not weld or score even when in contact with a dry metal shaft. Because GRAPHITAR operates with *any* liquid as a lubricant, it is an ideal bearing material wherever low viscosity liquids such as gasoline are encountered.



Self-aligning seals of GRAPHITAR are employed in rotary pressure joints handling steam, water, hot oil, trichlorethylene, powdered talc and a variety of chemicals. GRAPHITAR has the ability to withstand the action of many such chemicals and only very highly oxidizing reagents in hot and concentrated form can react to destroy GRAPHITAR.



GRAPHITAR is a material uniquely designed by its nature for solving tough problems and improving processing, and it can be further custom-engineered to meet your exact specifications. For complete information on GRAPHITAR . . . send for Engineering Bulletin # 20.

THE UNITED STATES GRAPHITE COMPANY



DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN
GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

Circle 272 on Page 19



Cylinder ports side and bottom tapped, $\frac{3}{8}$, $\frac{1}{2}$ or $\frac{3}{4}$ in. NPT; through ports tapped both ends and bottom, supply—1 in. NPT, exhaust and wiring conduit ports— $\frac{1}{4}$ in. NPT; meets JIC Standards.

to save space . . .

to simplify piping and wiring

New PDQ MODULAR MANIFOLD BASE

Now you can save even more space by ganging already-compact Hunt $\frac{1}{2}$ in. PDQ valves on modular manifold bases!

Featuring common supply, exhaust and wiring conduit ports, PDQ modular manifold bases can be ganged end-to-end to manifold two or more valves in a single, compact assembly. Manifolding of valves simplifies supply and exhaust piping, reduces installation costs and minimizes mounting space requirements for multiple valve installations. Modular design permits adding or removing valves at a later date, to meet changing requirements. Also, bottom tapping permits additional supply, exhaust, or wiring connections at any point along the manifold assembly, if required.

Electrical connections, valve-to-base, are plug-in, to reduce downtime to a minimum. What's more, the bayonet-lock construction of Hunt's PDQ valve allows removal and installation of valve and pilot assembly in just 30 seconds, without disturbing piping or wiring.

Whether your problem is limited valve mounting space . . . complex piping . . . high installation costs . . . or you're just looking for better, lower cost, more dependable performance on new or existing equipment, ask your nearby Hunt representative to show you the advantages of modular manifold base-mounted PDQ valves.

For more information, write for Bulletin 602, Address Hunt Valve Company, Salem, Ohio, Dept. MD761.

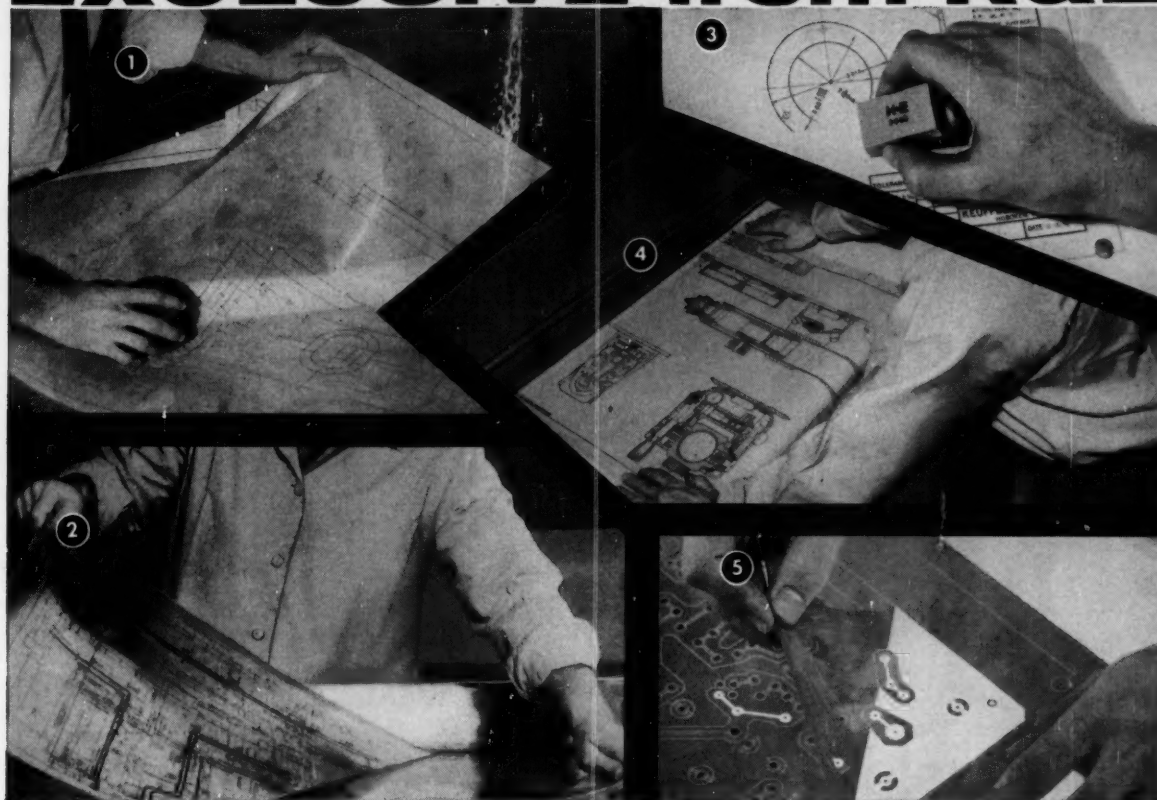
HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

EXCLUSIVE from K&E



the Complete Line on Polyester Film and every film with "engineered" drafting surface

Only K&E offers you all the film-based media for your drafting and reproduction needs, and they're all *working* products, designed to permit additions or deletions. The same engineered drafting surface throughout enables you to standardize on drafting techniques, and the same base throughout means constant behavior characteristics under exposure to light, heat, moisture, etc.

1. HERCULENE® — the unchallenged leader among drafting films, with better than ever working properties for pencil, ink, and typing. Now with a choice of specialized writing mates: *Duralar* plastic pencils render tracings that are completely washable in soap and water . . . new *Ruwe* pencils have all the fine "feel" of graphite, yet resist smudging better than graphite on regular paper.

2. PHOTACT® — the photographic second original *on film* that can be processed with regular *paper* developer. Image lines can be *manually* erased, too (no eradicators needed). Underneath — an excellent drafting surface for changes or additions in pencil, ink or typing. Available in three film types: Contact, Direct Positive, and Projection.

3. DUPRO® — for ink-like second originals that can serve as working copies. Image lines are smudge-proof, with appearance and permanence of photography, yet are easily removed with soft vinyl eraser. For additions or changes in pencil, ink or typing: a perfectly balanced drafting surface underneath. Another advantage: wash-off emulsion permits processing in room light — *no darkroom needed*.

4. HELIOS® — for intermediates of exceptional ruggedness, produced easily, quickly, and at *low cost* by the standard dry diazo process. Mechanical erasure removes image lines (no eradicators needed); engineered drafting surface on the reverse side. Unsurpassed line density and background clarity — black line or sepia.

5. STABILENE® — the *re-stabilized* drafting medium with unsurpassed dimensional stability. Ideal for highly precise work, like the preparation of multi-color maps, printed circuitry, lofting layouts, tools and templates, etc. Available with more than 20 types of surfaces — for pencil and ink work, scribing, peeling, stripping, and a variety of reproduction methods.

For more information on any of these popular K&E polyester-base films, simply mail the coupon below.

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3093-A

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... with Spaulding Value Analysis Engineers putting their heads together over your product

Spaulding interprets the Value Analysis Process as "a scientific method of accomplishing a function at the lowest possible cost."

That's why Spaulding maintains specially trained Value Analysis Engineers on its sales staff who evaluate a customer's product, then decide how it can be made better, easier, and at a lower cost through the use of a Spaulding material processed by Spaulding's own Fabricating Department.

These men save Spaulding's customers thousands of dollars annually. Why not let them put their heads together for you?

The Unique Characteristics of these Spaulding Materials and Services Hold Important Advantages for your product.

Spaulding Vulcanized Fibre: Hard, dense, extremely wear-resistant. One of the best arc-resistant, electrical and heat insulators known to industry.

Spauldite: Industrial plastic laminates.

Spauldo: A 100% rag paper electrical insulation used as motor slot insulation.

Spaulding T: A very high grade fibre board. Also known as Press-board, Transformer Board and Fuller Board.

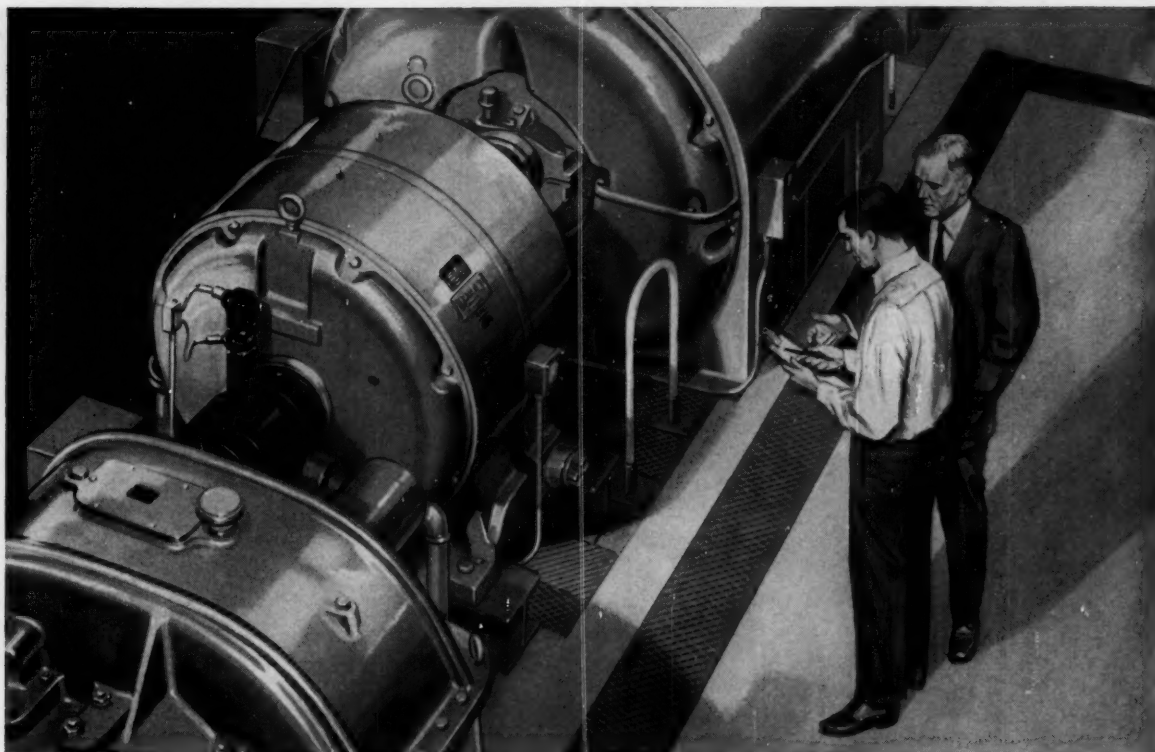
Spaulding Armite: An improved thin vulcanized fibre insulation (fish paper)

Spaulding Fibre Board: Made by the wet process from selected fibrous materials in various grades, including resin boards.

Fabrication Facilities: Undivided responsibility from manufacturer to finished part, with the most complete fabricating facilities in the industry

SPAULDING FIBRE COMPANY, INC.

328 WHEELER STREET, TONAWANDA, NEW YORK



Place Your Speed Control Problems in the Hands of Experts!

As the originator and leading producer of eddy-current speed control equipment, it is only natural that Eaton-Dynomatic offers many exclusive design and construction advancements—plus expert engineering service.

The transmission of torque across an air gap by means of eddy-currents is a fundamental Dynamatic development. It was first utilized 30 years ago, and is today the operating principle of a full line of couplings, brakes, drives, and dynamometers serving industry wherever accurate control of speed and torque is required.

Eddy-current equipment runs on standard AC—requires no special power source. Electronic or transistorized magnetic amplifier controls, engineered and manufactured by Eaton, provide constant speed, infinitely adjustable speeds, and many specialized operating functions.

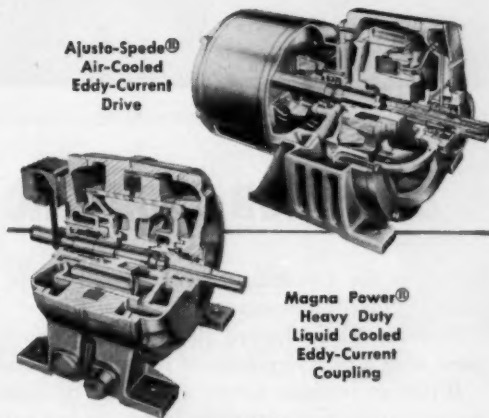
Representatives, located in all principal cities, are fully qualified to give you expert help with your speed control or torque transmission problems. Call the Eaton-Dynomatic representative nearest you today—there's no obligation.

Send for Illustrated Literature.

EATON

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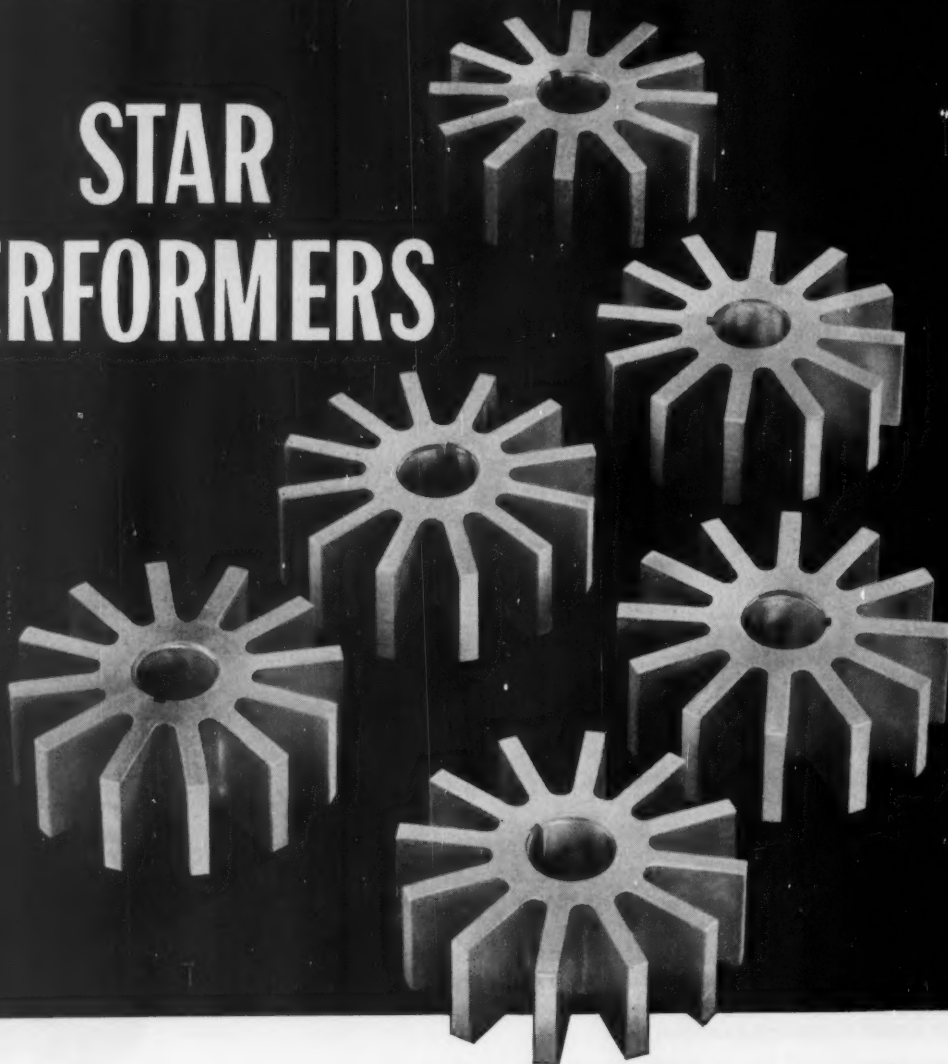
**Adjusto-Speed®
Air-Cooled
Eddy-Current
Drive**



**Magna Power®
Heavy Duty
Liquid Cooled
Eddy-Current
Coupling**



STAR PERFORMERS



Madison-Kipp zinc and aluminum die castings

Impellers for a ventilator pump must be held to extremely close tolerances.

Madison-Kipp showed the way to produce these parts with a bare minimum of secondary operations.

If it is an intricate shape, a question of close tolerance, a problem of casting-in inserts or just a dependable source for quality castings in quantity, the engi-

neering skill, die making experience and years of manufacturing background of Madison-Kipp are available to you.

We have a 24-page book showing some of the die casting problems we have solved, and containing information on other Madison-Kipp products. A copy is yours for the asking.



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Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High-Speed Air Tools

HOW TO HANDLE 3 Basic Timing Functions With ONE HAYDON CONTROL

Haydon Series DA Time Control Performs All Basic Timing Functions with Simple Timer and Relay Set-ups . . . Saves You Money, Simplifies Your Engineering.

This reliable, low cost timing device easily adapts to hundreds of applications, avoiding the need for custom-built timers.

The Haydon Series DA Time Delay Timer is designed around a motor with a magnetically operated clutch. When the motor is energized, the clutch is engaged and the motor shaft drives an arm which . . . at the end of the desired interval . . . actuates a switch. When the motor is de-energized, the clutch disengages, permitting the arm to be reset by a spring.



DA-11 — Hand set dial reading in seconds. Long terminal board; ranges up to 4.5 minutes.

DA-21 — Lock wrench set dial reading in percentages. Short terminal board; ranges up to 9.5 minutes.

SPECIFICATIONS

Switch Ratings — SPDT 20 amps, 125 or 250V ac resistive load. Maximum inrush: NC contacts 30 amps, NO contacts 15 amps. Switch capable of handling small fractional horsepower motors and components meeting these specifications. Other switches available.

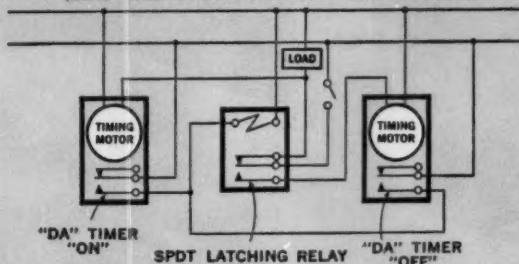
Timing Motor Voltages — 120 or 240 volts, 50 or 60 cps.

Delay Ranges — Time delay of 0 to 14 seconds, 0 to 57 seconds, 0 to 4.5 minutes, 0 to 9.5 minutes.

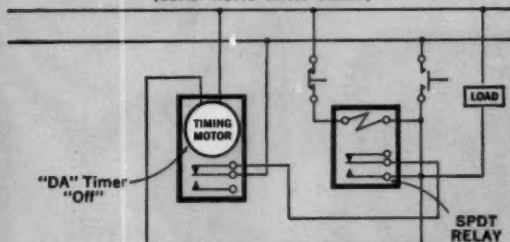
For details on DA Series Time Controls, write to:

**TIMING MOTORS
TIME AND TORQUE CONTROLS**

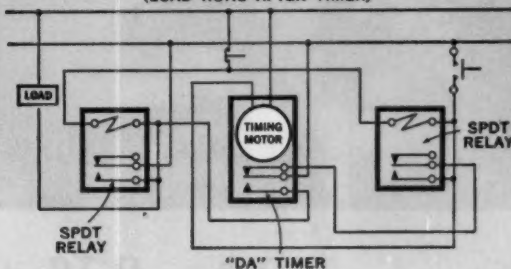
CYCLE TIMING: (with 2 Timers, 1 Latching Relay) (LOAD CYCLES "ON" AND "OFF" CONTINUOUSLY)



INTERVAL TIMING: (with 1 Timer, 1 Relay) (LOAD RUNS WITH TIMER)



TIME DELAY TIMING: (with 1 Timer, 2 Relays) (LOAD RUNS AFTER TIMER)



**DIVISION OF GENERAL
TIME CORPORATION**

**3131 EAST ELM STREET
TORRINGTON, CONNECTICUT**



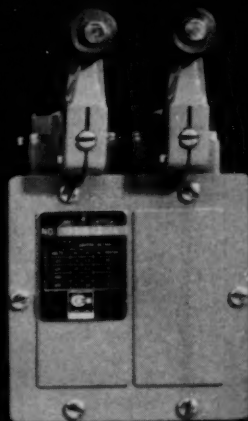
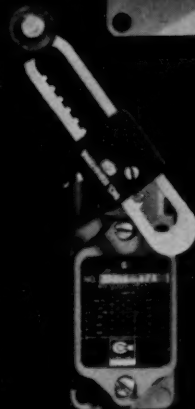
What's your problem? If you can solve it with a

*New Cutler-Hammer operator options provide top flexibility...
world's best oiltight limit switch*

For any use, anywhere, in any position . . . you just can't buy a more reliable, longer-life switch. No other switch is sealed more effectively . . . effectiveness we've proved under test conditions so rugged they will never be equaled in actual service. Even the silver-to-silver contacts are visible for quick in-

spection. For full details on this complete new line, write for Pub. ED-145-P243.

For any electrical control problem, contact your local Cutler-Hammer sales office or distributor. They'll supply you with the finest electrical components, the finest service and technical help.



Many operator options, many special new features, including four position operator head.

limit switch, your best answer's here!

WHAT'S NEW? ASK...

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Cutler-Hammer Canada, Ltd.; Cutler-Hammer Mexicana, S. A.



Circle 279 on Page 19

how to build a house in a day...



1 Floor panels are locked to joists laid on permafrost ground.

2 Doorway is first wall panel to go up. It locks to floor.

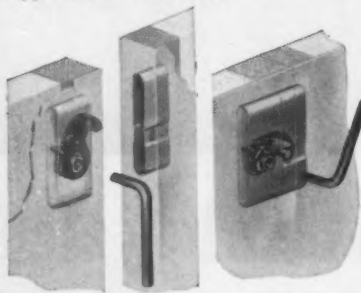
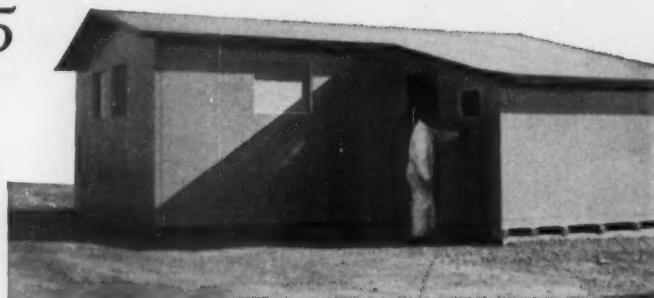
3 Walls and partitions lock to floor and to each other.

4 Roof panels go on last. This takes about three hours.

5 Complete in 7 hours! Floor, walls, roof panels—It's all done with Simmons Dual-Lock fasteners.

Standard Dual-Lock withstands 2500-lb. tension; may be modified for high-load applications to 4500 lbs.

5



■ This house is put up in a day — and can be taken down in half a day!

■ Key to quick assembly-disassembly is the Simmons Dual-Lock.

Dual-Lock is a high-load, positive-locking structural fastener perfectly adapted to panel fastening of demountable shelters, shipping containers, covers, cowlings... and to all butt-joint fastening jobs. It can be recess-mounted as in the application pictured, or surface-mounted on sheets or panels. Locks with heavy closing pressure, with very light pressure required on the key.

Arctic Units, Ltd., Toronto, Canada, is putting up 90 "Eskimo Houses" on the DEW Line. Panels, including roof, are plywood-covered plastic foam designed for insulation against Arctic cold.

WRITE FOR CATALOG 760. Complete details of Dual-Lock and other dependable quick-operating Simmons Fasteners with unlimited money-saving applications.

■ Samples and engineering service available upon request.

SIMMONS FASTENER CORPORATION

1756 North Broadway, Albany 1, New York

LINK-LOCK • HINGE-LOCK • HOOK-LOCK • SPRING-LOCK • CAM-BOLT • DUAL-LOCK • QUICK-LOCK • ROTO-LOCK

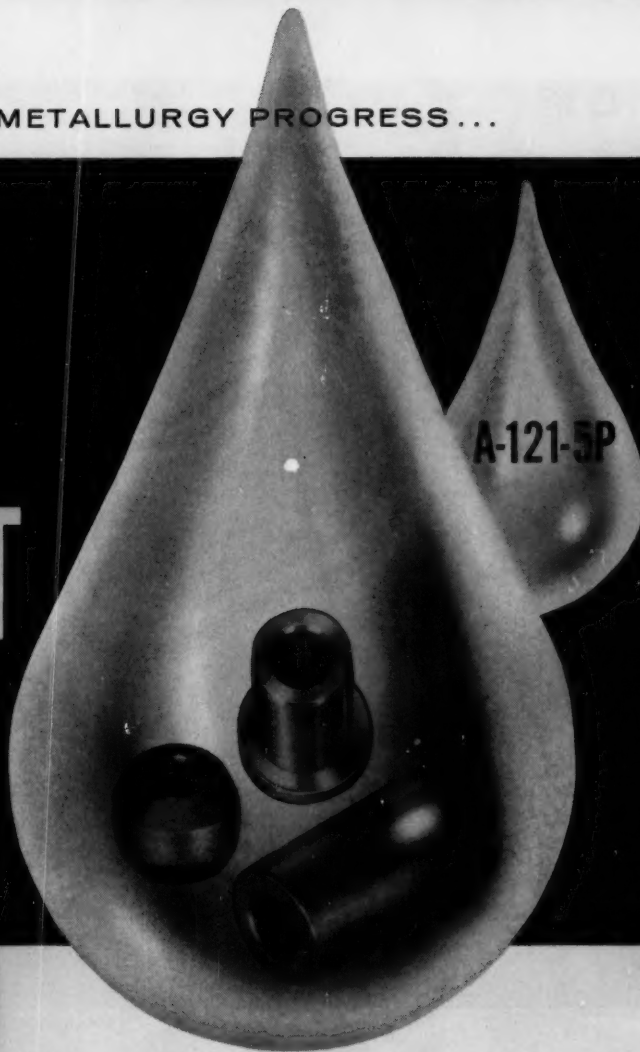
KEYSTONE POWDER METALLURGY PROGRESS...

NEW

Keystone
LUBRICANT

3 to 4 TIMES

...the most significant
development in
self-lubricated bearings
over the past 10 years!



QUIETER—no squeal on thrust!
Withstands **300°F** service in FHP motors!
EXCLUSIVELY KEYSTONE!

These striking improvements in standard Keystone C-64 bearing performance are created by new lubricant A-121-5P—the greatest advance in porous bearing lubrication in a decade!

Exclusively a Keystone Carbon Co. development, Formula A-121-5P is the result of research and intensive study of all available petroleum and synthetic base lubricants, in close cooperation with all major oil companies. A-121-5P is obtainable only from Keystone Carbon Company as the impregnant of bearings of Keystone manufacture.

Already in wide use in small appliances, disposers, washing machines and FHP motors, A-121-5P lubricated bearings are delivering 3400 hours of service in applications with previous maximums of 800 hours—at lower noise levels—without sludging or breakdown over 200°F.

Would you like to test your bearings with A-121-5P? Write, on your letterhead; send us your samples—you be the judge!



K

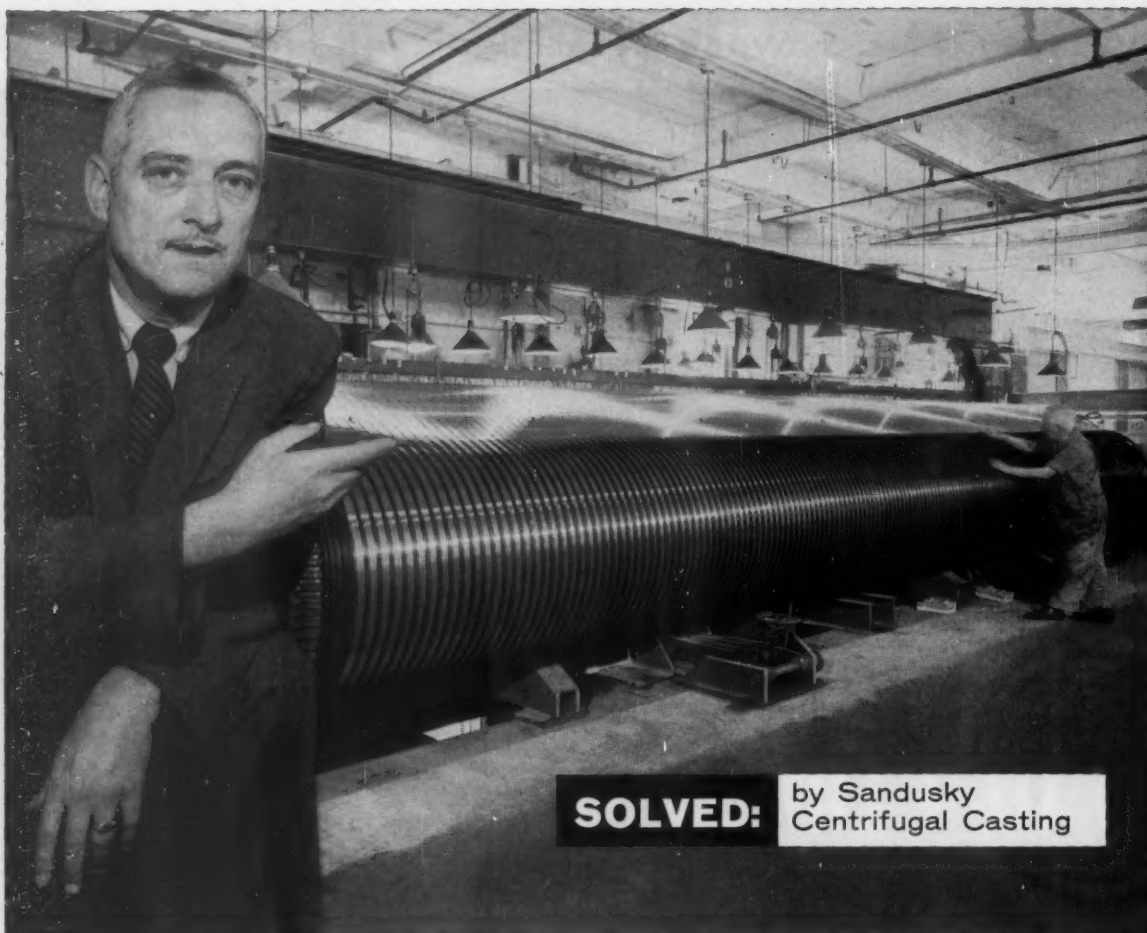
Keystone

CARBON COMPANY

POWDERED METAL PARTS DIVISION

ST. MARYS, PA.

Circle 281 on Page 19



SOLVED: by Sandusky Centrifugal Casting

Eastwood-Nealley's chief engineer points out great size of grooved cylinder

Who else could cast this 22-ton cylinder for the world's biggest wire cloth loom?

To weave Fourdrinier wires up to 352" wide for the world's newest and largest paper machines, Eastwood-Nealley Corp., Belleville, New Jersey, required a cylinder over 30 feet long.

Sandusky supplied this 44,685 lb. roll, centrifugally cast of SAE-1030 steel and rough machined to 363" in length, 40% on the O.D., to be used as the backbeam on Eastwood's new wire cloth loom. Since the cylinder had to be machined with 176 extremely smooth 2" x 2" stirs (grooves) in which wire is wound, it had to be of *flawless quality*. Otherwise any voids or inclusions exposed by machining would nick the delicate bronze strands and cause the expensive wire cloth to fail.

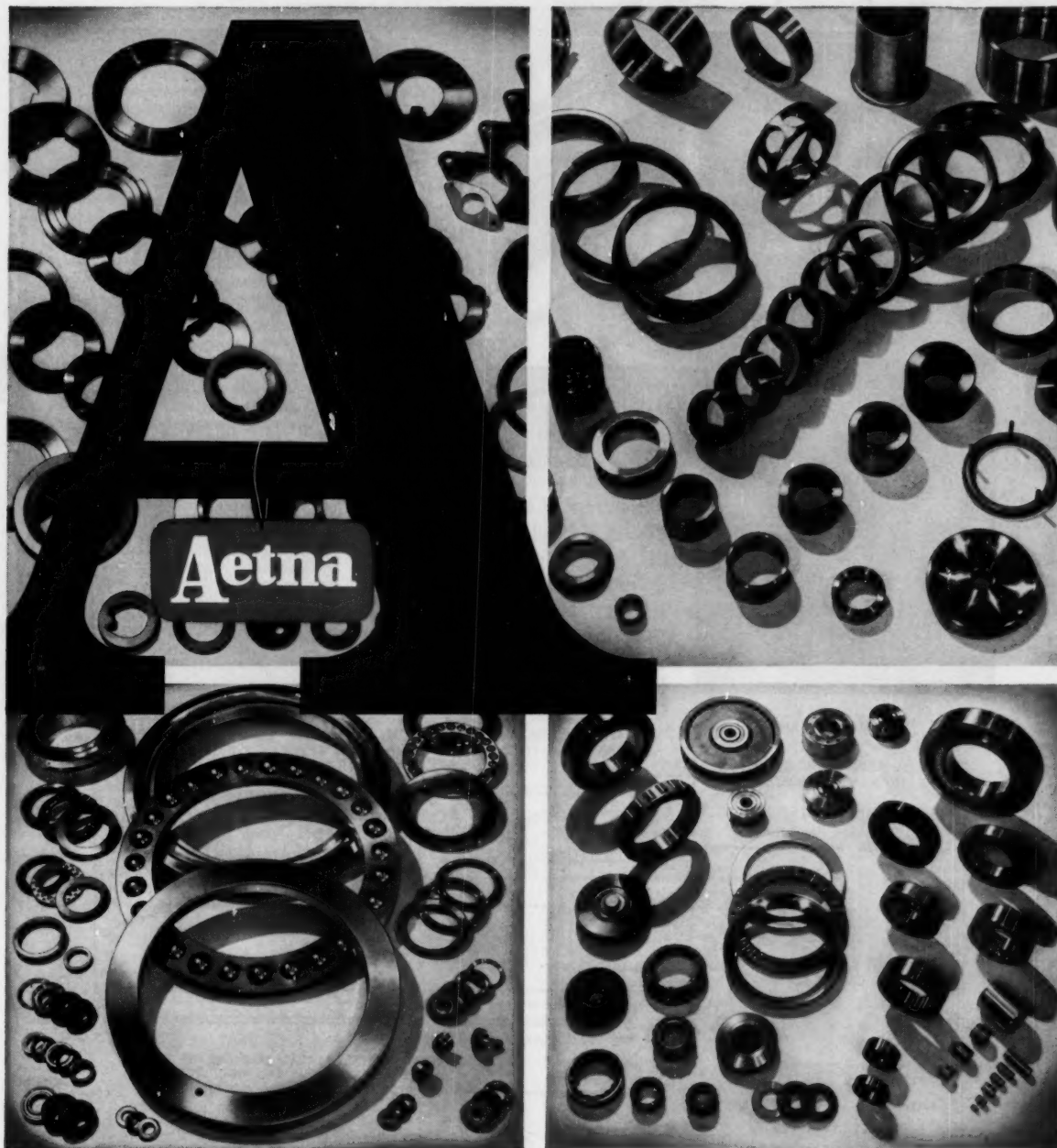
Eastwood-Nealley's chief engineer, Clemson A.

Bower, asserts: *"We chose a Sandusky Centrifugal Casting because only Sandusky could make such a gigantic cylinder without welding. We were confident that our special machining operation would be accomplished without costly re-makes, for in the 12 years we have been using them, we never found a single flaw in a Sandusky Centrifugal Casting!"*

When cylinders or piping are needed in your design, keep Sandusky Centrifugal Castings in mind. We can supply cylindrical products from 7" to 54" O.D. and up to 33 feet long—made from a variety of alloys including stainless, carbon and low-alloy steels as well as copper- and nickel-base alloys. Send for free booklet, "Your Solution to Cylindrical Problems."

SANDUSKY  **CENTRIFUGAL CASTINGS**
FOUNDRY & MACHINE CO.

WHEN YOU NEED SPECIALS If your product calls for special bearings or hardened and ground precision parts, Aetna's many years of specialization in these areas can save you money. In fact, many times, original equipment manufacturers find their problems have already been studied and resolved by Aetna's engineers and that tooling is available. For other special units, Aetna can step in at any point—from research through design, testing, or production, to help solve your specific problem. Ask your Aetna representative—listed in your classified telephone directory—for detailed information on our design and production facilities, and outline your anti-friction or parts needs for our study, consideration, and recommendations.



AETNA BALL and ROLLER BEARING COMPANY
DIVISION OF PARKERSBURG-AETNA CORPORATION

4600 SCHUBERT AVE.
CHICAGO 39, ILL.

ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916



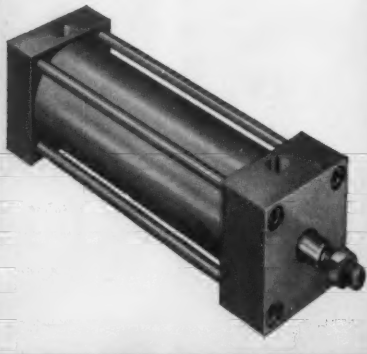
NEW FROM HANNIFIN

A GENERAL PURPOSE AIR CYLINDER

that gives you quality, low cost and mounting versatility

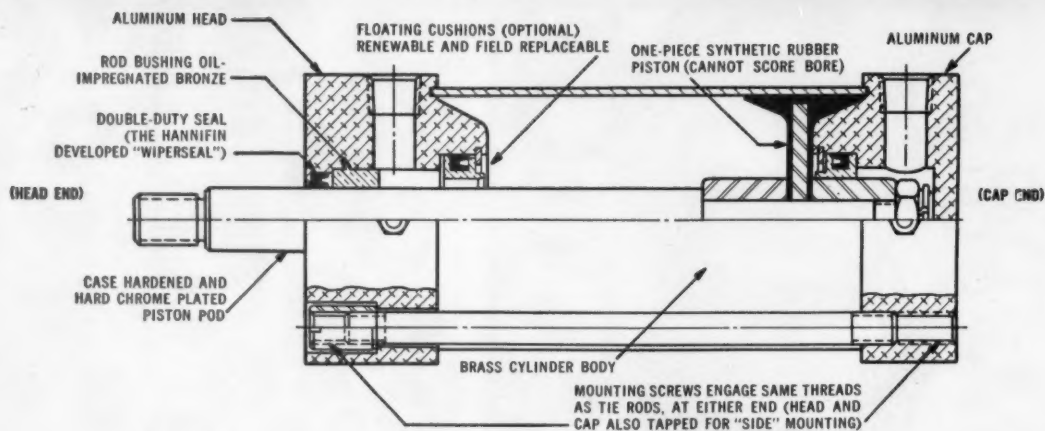
Hannifin announces a new design concept that gives you quality and economy in one

package, the new Series "C" air power cylinder with . . .



This new Hannifin cylinder design is the latest of the complete Hannifin line of air power cylinders. To help you choose the best Hannifin cylinder for your application, talk to your nearby Parker-Hannifin man. He knows cylinders!

- One compact basic design that provides side, cap end, or head end mounting without modification.
- Flange, foot or pivot mountings easily made with standard attachments.
- Rust proof construction — brass cylinder body, head and cap of aluminum.
- Cushions that do not change cylinder length — furnished as option or added in field with simple kit.
- An ingenious one piece piston that cannot score the bore — of synthetic rubber, molded around a rugged steel disc.
- Piston rod both case hardened and hard chrome plated, polished to a fine finish for low friction and long seal life. Corrosion resistant.
- Rod bearing an oil impregnated bronze bushing. Minimizes friction.
- Gland seal the Hannifin-developed "Wiperseal" — both a rod wiper and an efficient dynamic seal. It keeps air in, dirt out.
- 5 bore sizes — 1/4", 3/8", 1/2", 3/4", and 1". Stock strokes from 1" to 20" in 1" increments.



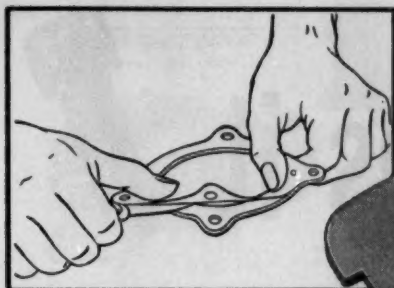
HANNIFIN COMPANY

A DIVISION

515 South Wolf Road • Des Plaines, Illinois

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS



Never underestimate the
cost-saving advantages of
LAMINUM®

We address this statement to design, tool, production, inspection and assembly engineers...

Holding to extremely close tolerances is a costly procedure. You know that. What you may not know is that frequently you can ease up on tolerances without sacrificing a single thousandth of your precise assembly objectives.

How? By using LAMINUM!

LAMINUM is the registered trade name for laminated shims whose layers are completely surface-bonded to look and act like solid metal. The layers are easily p-e-e-l-e-d to bring the shims to any desired thickness—for a thousandth fit right at assembly.

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Circle 285 on Page 19

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PQA* proves it



This Allen screw passes
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under high load conditions

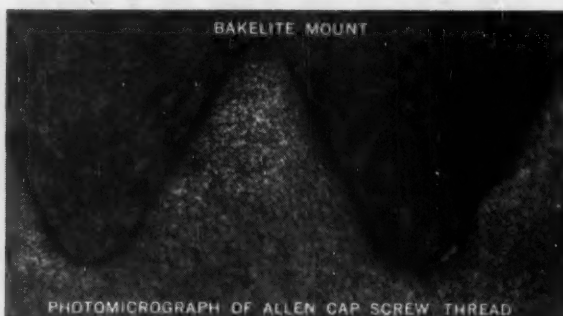


BAKELITE MOUNT

PHOTOMICROGRAPH OF COMPETITIVE CAP SCREW THREAD

50X Magnification—unretouched

Here you see a competitive socket-head cap screw where thread laps and deep decarburization (lighter area running through roots of threads) caused premature failure of the screw. When used under high load conditions in an outboard crankshaft-connecting rod-piston assembly, such a screw failure would cause great motor damage.



BAKELITE MOUNT

PHOTOMICROGRAPH OF ALLEN CAP SCREW THREAD

50X Magnification—unretouched

Now look at this Allen Socket Cap Screw. Photo was taken during regular quality control test and shows no thread lap or decarburization. Allen is producing to and inspecting in accordance with MIL-B-7838A for thread discontinuities—your assurance of quality!

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PQA is the symbol of unquestioned quality at Allen. It stands for *constant* quality control from rigid upgrading of incoming raw materials to shipment of finished products—*plus* an unconditional guarantee that backs up every order!

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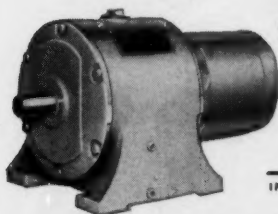
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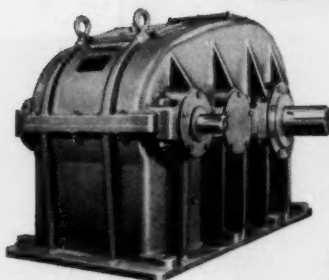


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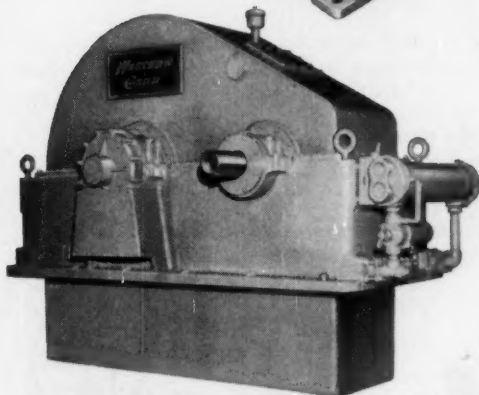
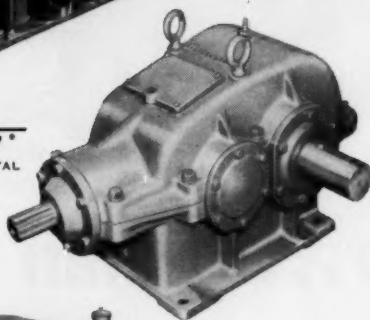
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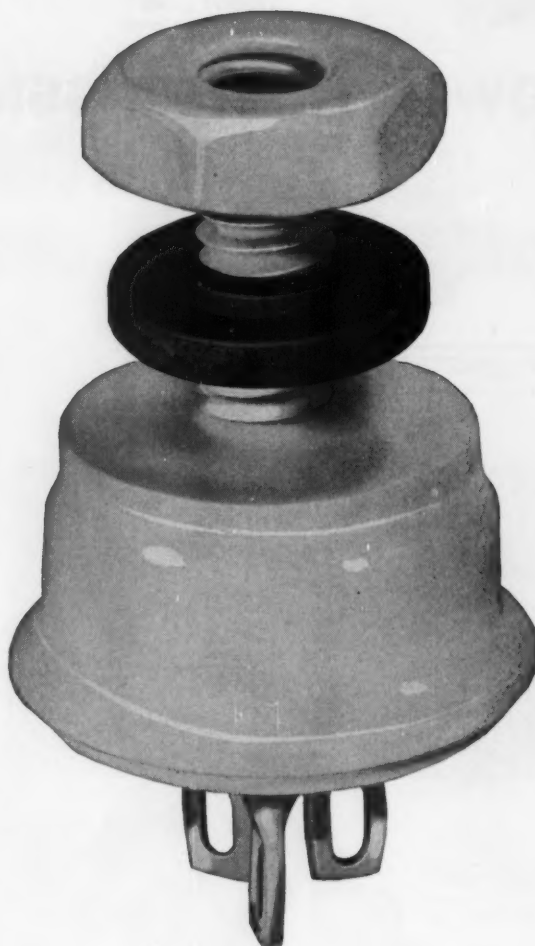
A few facts on the tubing: (1" x 1½")

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Min. density 1.12

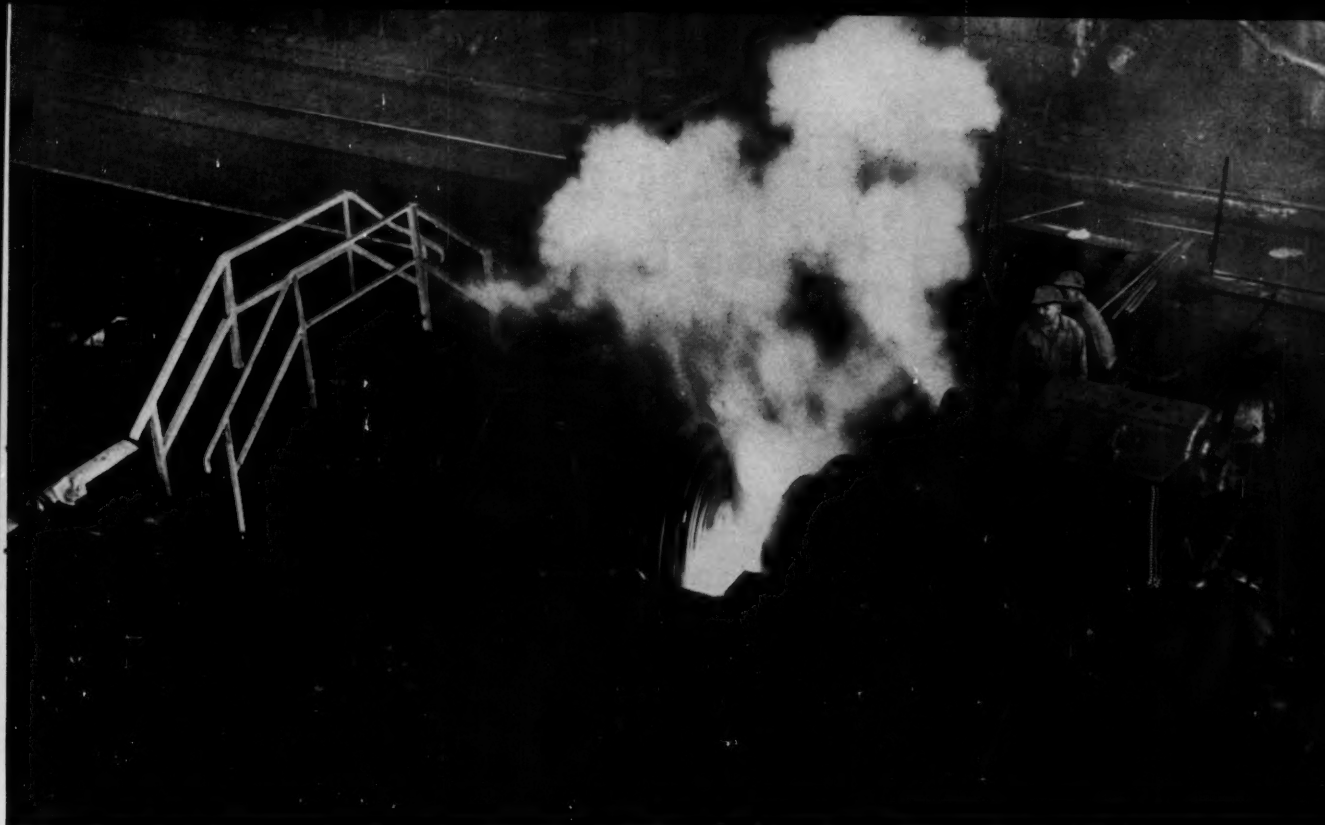
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START: Heated billet is centered between dies of the Slick Mill.



15 SECONDS
Upset-forging starts.



30 SECONDS
Rolling cycle starts.



40 SECONDS
Forging is completed.



55 SECONDS
Forging is removed from mill.

One minute... one circular forging

That's all the time it takes to convert a heated billet (100 to 2,000 lb) into a contoured forging on Bethlehem's unique Slick Mill.

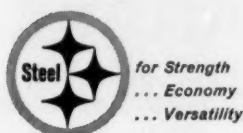
But fast operation is only one reason why Bethlehem's Slick Mill turns out a top-quality forging at a price that's hard to match.

Ask us, or our nearest sales office, about the quick die changes, which make it possible—and economical

—to set up production runs as small as 25 or 50 pieces. Ask about the low die charges which are made possible by the brief contact between die and work. Ask about the light-weight sections this mill can produce, without sacrificing strength.

We'd also like to tell you about the excellent grain flow, machinability, and soundness of every Bethlehem circular forging.

Ask. You'll like the money-saving answers.



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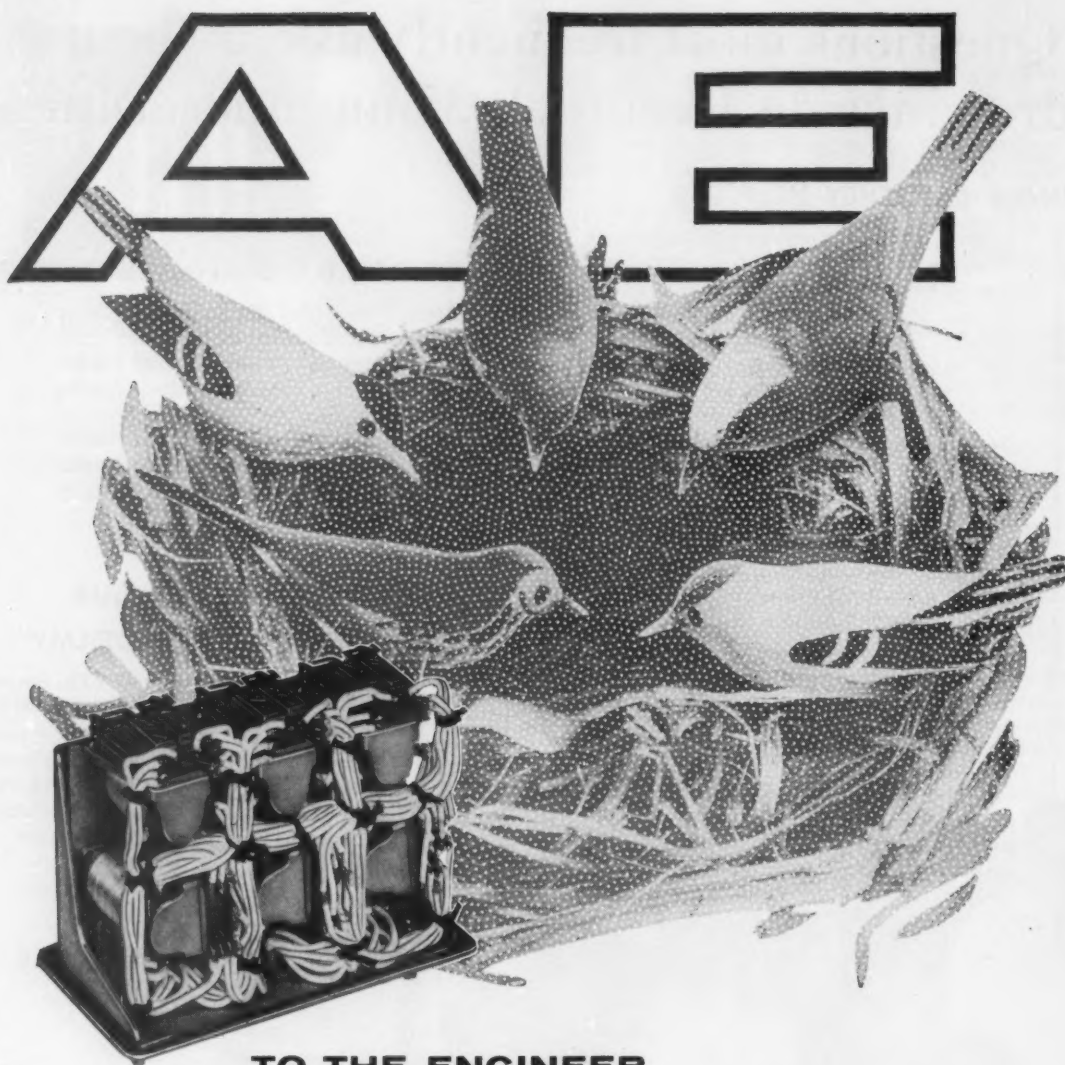
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TO THE ENGINEER

who thinks "birds' nests" are for the birds...

Upset over the fancy wiring your control package demands? Relax! AE can turn a bird's nest into a thing of beauty *and* high reliability. The reason is simple: we've had years of experience wiring complex dial telephone switchboards, to say nothing of little black boxes. And we have the techniques down so tidy and pat that our assembly and rewiring costs are more than likely lower than yours.

As a beautiful example, take a look at the compact relay complex illustrated. This custom job is designed to do switching tricks over and over

again without failure. A significant part of its dependability is structural rigidity.

AE engineers are also gifted in solving the most complex switching circuits in the simplest and most inexpensive way. Chances are they can save you some headaches.

If you have a control problem, we'd like to hear about it. Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. And while you're at it, ask for Catalog 4083-A covering *AE Enclosures for Relays, Switches and Control Systems*.

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DO**



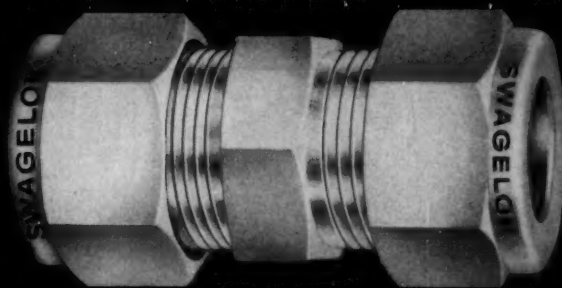
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WHY WAS THIS TUBE FITTING MADE FROM PLATINUM?



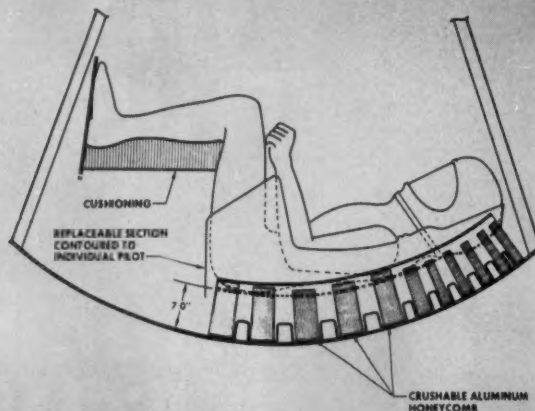
This Swagelok tube fitting was machined from Platinum because that is what our customer needed for his nuclear reactor experiments. This is just one of many outstanding examples of Swagelok customer service. The scientist who needed this fitting knew that Swagelok tube fitting reliability would meet the exacting requirements of leak tightness for nuclear work. He also knew that full cooperation in delivering Swagelok in any machineable metal is routine.

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HEXCEL HONEYCOMB ABSORBS 9G's FOR ASTRONAUT



When Freedom VII opened its parachutes after re-entry, Hexcel crushable aluminum honeycomb absorbed 9 g's deceleration force, to help bring the first U. S. astronaut safely back to earth.

Use of crushable honeycomb for control of forces on decelerating objects is now being applied to such varied tasks as packaging fragile items, providing impact-limiting linkages in landing gear structures and cushioning the impact of air-dropped supplies.

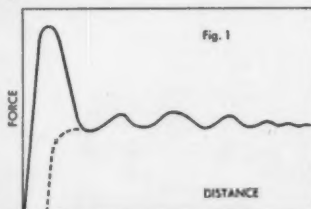
The Problem

Instances requiring impact energy absorption are generally typified by low tolerable deceleration rates for the structure or its contents, high impact velocities, and small maximum allowable stopping distances. Such absorbers as mechanical springs, sponge or solid rubber, foams, cork, and wadding generally exhibit spring characteristics, in that the force transmitted through these absorbers to the object being stopped increases continuously through the distance in which the absorbers contract. In addition, many of these materials do not absorb energy, but merely store it for release as rebound energy.

If an absorber could exert a relatively constant non-rebound force throughout the entire stopping distance, that distance could be shortened, or alternately, the maximum force acting on the object in the same stopping distance could be materially reduced.

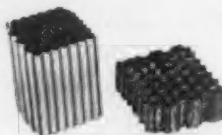
Advantages of Honeycomb

Honeycomb core materials tend to follow such a constant force curve, as shown in Figure 1.



The initial peak on the curve represents the point at which compressive failure begins. This peak can be lowered by prestressing the core to produce slight initial compressive failure. When subjected to further or subsequent loading, the prestressed core proceeds immediately to carry the crushing load, as shown by the dashed line curve in Figure 1.

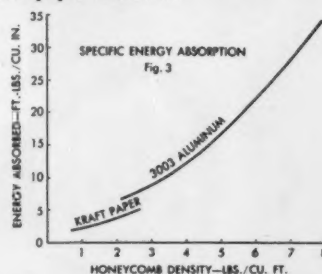
Figure 2 illustrates the appearance of aluminum honeycomb core before and after compressive failure.



By designing a honeycomb core assembly with a specified cell depth this constant force can be applied over a predetermined stopping distance.

Available Materials

These principles apply to aluminum and paper honeycomb, and most similar honeycomb core materials fabricated from ductile metals and fabrics. Figure 3 indicates the general range of energy absorption capacity available in aluminum and paper materials.



These capacities can be further increased by filling the cells with various foamed materials.

Optimum Solution

The choice of materials by the designer will depend upon the particular requirements of the application. But it seems apparent that the utilization of honeycomb offers the optimum solution—in terms of weight and volumetric efficiency—to many types of energy absorption problems.

If you would like further information on the uses of honeycomb for energy absorption or other applications, consult *Sweet's Product Design* catalog or complete the information request at left.

INFORMATION REQUEST

Send to Hexcel Products Inc. Dept. C-7
2332 Fourth Street, Berkeley 10, California.

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Executive Offices: 2332 Fourth St., Berkeley 10, Calif.

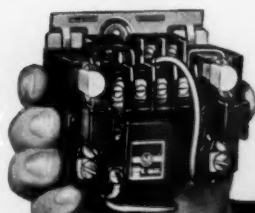
Plants: Berkeley, Oakland, El Segundo, Calif.; Havre de Grace, Md.

Sales Offices: Inglewood, Calif.; Fort Worth, Texas; Chicago, Ill.;

New York, N.Y.; Havre de Grace, Md.

You get more value for the same dollar— in the NEW Bulletin 709 line of starters!

Size 00
1½ HP, 220 V
2 HP, 440/550 V



Size 5
100 HP, 220 V
200 HP, 440/550 V

This new line of Allen-Bradley motor control will change every idea you have had about starter size, performance, and life. The small size—especially in the higher ratings—is startling. Yet rating for rating the operating life and reliability have been increased many times. Built into each of the seven sizes of this new Allen-Bradley line is an ability to interrupt tremendous currents and to operate year in and year out for many millions of operations without trouble or maintenance.

The new Bulletin 709 starters are just as advanced in appearance as they are in performance. All seven sizes have an aristocratic styling and a distinctive family likeness. Brooks Stevens, famous industrial designer, has given the enclosures such an attractive, modern style that these new starters will prove a distinct sales asset on any machine or installation.

Why not write today for more information on this revolutionary new line of Allen-Bradley Bulletin 709 quality across-the-line motor starters?

Note the compactness of both the smallest and largest starter in the new Bulletin 709 line. Ratings up to 100 hp, 220 v; 200 hp, 440-550 v.

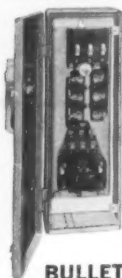
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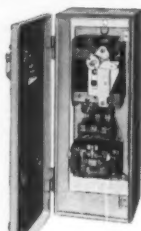
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Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

**QUALITY
MOTOR
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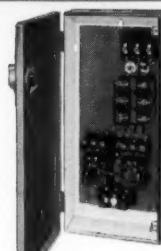
BULLETIN 712
Size 1 combination
starter with fused dis-
connect switch



BULLETIN 713
Size 1 combination
starter with circuit
breaker



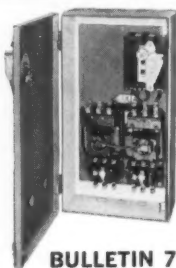
BULLETIN 705
Size 2 across-the-line
reversing starter with
overload relays



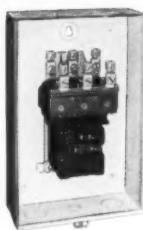
BULLETIN 706
Size 1 reversing starter
with fused disconnect
switch



BULLETIN 715
Size 1 across-the-line,
multi-speed starter with
overload relays



BULLETIN 717
Size 2 multi-speed
starter with circuit
breaker



BULLETIN 702
Size 3 three-pole, a-c
solenoid contactor

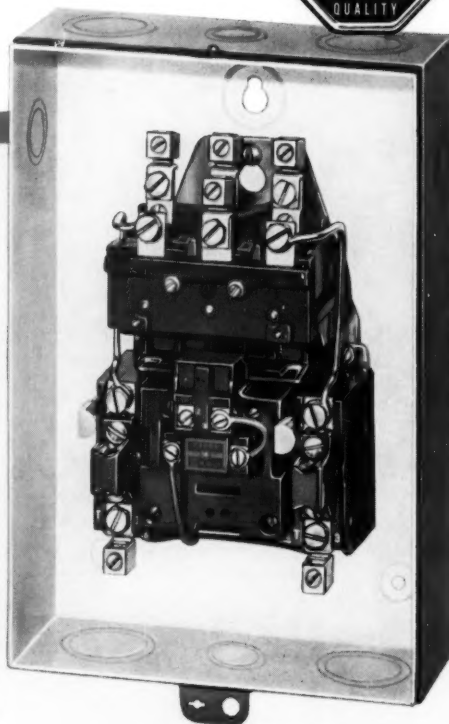


Pygmies in Size Giants in Performance— the NEW Allen-Bradley Across-the-Line Starters!

This new line of across-the-line motor starters is the result of over 30 years of experience and leadership in the motor control field.

While retaining the simple solenoid principle—with only ONE moving part—these starters are completely new in every way. They are amazingly small in size—yet test after test has proved they will not only outperform but also outlast any starter now on the market. They are good for *many millions* of trouble free operations. All have scores of design refinements that make them easier to install and maintain. All are available in the smart new enclosures designed by Brooks Stevens. They make a beautiful addition to any machine or control installation.

You'll want to get the complete story about these truly revolutionary new across-the-line starters. Write for new Publication 6100.



BULLETIN 709

This popular across-the-line solenoid starter shows the new Size 2 construction. Note the white interior and generous wiring space. Bulletin 709 starters are available, in the new construction, in seven sizes—Sizes 00 to 5, with a maximum rating of 100 hp, 220 v; 200 hp, 440-550 v.

12-61-RM

ALLEN-BRADLEY

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Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

QUALITY
MOTOR
CONTROL

July 20, 1961



Who's the Oddball?

IT had been Harry's first trip abroad. What really got him was the crazy money system in Britain. Imagine, 12 pence to the shilling, 20 shillings to the pound. And when he put a penny ("Boy, you should see those cartwheels!") in the weighing machine his usual 182 pounds came out 13 stone!

His associates put up with his yacking until Tom spoke up. What about 12 inches to the foot, 3 feet to the yard, 1760 yards to the mile? Or 16 ounces to the pound? What about 231 cubic inches to the gallon, 43,560 square feet to the acre? Harry's only answer was a blank stare.

Tom's designs often incorporate ball bearings which come in metric sizes and require an unholy amount of figuring on inch-dimensioned housing tolerances. And in Munich last year he learned that a liter of beer is not only all of a quart and more, but is also, for practical purposes, a nice round 1000 cubic centimeters. Now he is trying to convince Harry that we should throw out all our crazy measures and adopt the metric system like most other countries.

"You must be nuts," retorts Harry. "Do you want us to scrap all our rules, scales, micrometers, and gages? To have to teach people to think with all new numbers? Who can

picture a 16-millimeter bolt? It's too late to change now."

Too late? Maybe it is. Our international competitors may be foreigners in the countries where they are trying to extend their markets, but at least their products come in familiar sizes. They are busy now adopting all sorts of international dimensional standards which are leaving the U. S. in the oddball category. In the ISO, like the UN, each country has an equal vote.

A bill which would authorize a study to determine the practicability and desirability of the adoption of the metric system by the U. S. was introduced by Representative James Roosevelt in the current session of Congress. It has gone no farther than the Science and Astronautics Committee of the House.

But it doesn't require an Act of Congress to adopt the metric system within a company, an industry, or even a state. Use of the metric system was legalized in the U. S. back in 1866.

It may not be too late now, but considering the rate foreign countries are going, it very soon will be. What do you think?

Colin Carmichael
EDITOR

Ask any engineer how to price a new product. Chances are he'll say, "Cost plus a profit—about 15 per cent." Actually, prices are not set by product originators but by consumers. There's an optimum profit relation between selling prices and sales volume. Experience, systematically applied, helps find this optimum early. Engineers must share this responsibility because the price of any product depends directly on its design. This article provides a primer on pricing practices for engineers.



pricing new products

PHILIP MARVIN

Division Manager
Research and Development
American Management Association
New York, N. Y.

AN engineer is doing only half his job when he confines his thinking to technical parts of a project. The part of the problem that's often overlooked concerns dollars-and-cents relationships. Every product—every project—has a price. The price a customer must pay determines to a very large degree the success of a product.

For example, color television is a technical triumph but a commercial disappointment because the color television receiver is priced too high. Most people seem to want a color television receiver. They would be willing to pay more for a color set than a black-and-white set. But customers resist present differentials between color receivers and black-and-white receivers.

The economic facts of life are important to engineers and engineering managers because the price of any product depends directly on its design.

► Engineering's Whole Job

In developing new products and in redesigning older established products, engineers find themselves in responsible positions. Engineers must take new knowledge developed in the scientific laboratory and turn it into things that can be produced and that customers will buy. Only engineers can resolve the many complex technical factors which must be considered in balancing technical feasibility with economic feasibility in ways that lead to profits. In preparing engineers for advanced management positions, a good starting point is the development of price and profit perspectives.

It's an oversimplification to say that the engineer's job is to provide the greatest amount of function at the lowest possible cost. Engineers must also learn what customers want. Until they know this, engineers aren't really in a position to develop a device that will do a job at the lowest cost. The problem is complicated by the fact that customers don't always know what they want. This is true for both individual and industrial customers. It may take as much skill to develop preliminary specifications for a product a customer will

buy as it does to design actual hardware that meets these specifications.

Engineering managers must have enough imagination to anticipate things customers might buy. In addition, engineers must have sufficient analytical ability to measure and evaluate potential interest in these ideas, and sufficient technical skill to develop a prototype offering the greatest commercial promise. To do this, there are no rules, and few mileposts.

► Stumbling Blocks

Possibly the biggest stumbling block in thinking about products is the relationship between price and cost. If engineers were asked how the price of a product is calculated, nine out of ten would probably say that price equals cost plus a certain profit. This is common practice in pricing products, but this policy has little to recommend it when one examines relationships involved.

Engineers like nice, clean-cut, step-by-step procedures. They like right and wrong answers. They like relationships which can be added, subtracted, multiplied, and divided. They seem to think that there's too much guesswork in commercializing the end products of their efforts. To a degree, this may be true, but there is also considerable guesswork in the technical makeup of product development projects. Engineers are accustomed to this kind of guesswork. They call it judgment. The same kind of judgment must be exercised in putting price tags on new products.

If price projections are planned or programmed projections developed on a systematic basis in formulating a pricing strategy, experience will reveal ways of refining techniques. A planned program helps to hit closer to the target each time, Fig. 1.

► The Starting Point

Pricing new products should commence when the first tentative specification for a new product is

established. As the tentative specification is turned into physical hardware, new concepts will alter specifications. In turn, price and cost projections will influence design.

Since we are all customers for many products ourselves, let's consider our own reactions as a starting point. Look at some typical purchasing decisions. All of us have decided on one occasion or another that a particular product was too expensive. We decided that some other product was a good buy, that another was something we wanted regardless of price, and that still other products were ones we wouldn't want at any price.

For example, we may look at a color television receiver selling for roughly five hundred dollars and decide it isn't worth it to be able to receive a color picture.

We may see an imported English Meerscham pipe selling at a special price of two dollars and decide that although we hadn't planned to buy a Meerscham pipe, it can't be turned down at two dollars.

Having contracted a virus infection we take a prescription to the pharmacy and purchase an antibiotic preparation without any first thoughts about the price. Afterthoughts about the price we paid for the antibiotic are immaterial because we have made our purchase.

In a music store window we see a harp for sale for three thousand dollars. If the price were thirty dollars we wouldn't buy the harp.

In the face of this, how do we arrive at guide lines that will help to price a new product?

First, observe that decisions to purchase are influenced in varying degrees by actual needs and by personal reactions to the price. It is improbable that customers are concerned with the manufacturer's cost of producing the product, whether his cost was 10 per cent or 90 per cent of the selling price. Think in terms of retail prices, not manufacturing costs.

What about the purchaser of industrial items? What decisions must be made to authorize the purchase of raw materials and components? In most cases, specifications are established before bids are solicited. Factors such as low price, ability to meet delivery dates, and reputation for maintaining quality are some of the final determinants.

There are three different categories of industrial products: 1. Highly competitive products, such as nuts, screws and bolts, steel, radio tubes, and paint. 2. Radically new products, such as a sun-powered cell for portable radios. 3. Specialty products supplied by a single source.

How do purchasers react to the prices of products in each of these categories? In purchasing highly competitive products such as steel, the purchasing decision is seldom, if ever, influenced by price. Regardless of the supplier, the price will be the same.

For pricing purposes, radically new products and specialty products can be considered together. In almost every case, the radically new product is offered by a single supplier. If this product can be protected by patents or other methods, the supplier who introduces the product will remain the single source of supply over a period of time. As a

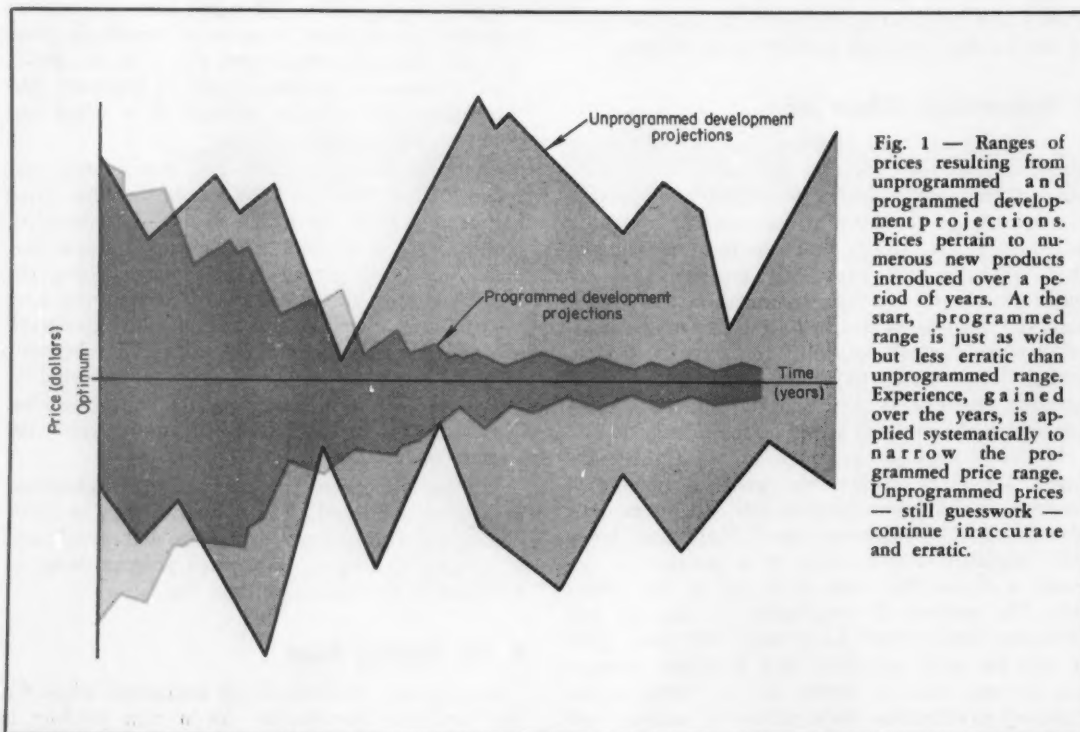


Fig. 1 — Ranges of prices resulting from unprogrammed and programmed development projections. Prices pertain to numerous new products introduced over a period of years. At the start, programmed range is just as wide but less erratic than unprogrammed range. Experience, gained over the years, is applied systematically to narrow the programmed price range. Unprogrammed prices — still guesswork — continue inaccurate and erratic.

result, the radically new product and the specialty product can be regarded as different points in the product life span.

The usual assumption is that the supplier has complete control over price of this radically new product. Assume further that a high price can be placed on a new product. This will result in high initial profits, but will attract competition. On the other hand, a low price will result in the most rapid acceptance of a new product by the market. Assume further that this low price will increase the period of time taken to recover development costs, but will discourage competitors from entering the field. Another assumption is that a low price policy should be followed if one of the primary purposes of the new product is its complementary effect on the product line.

Such reasoning is based upon the belief that purchasers will be able to distinguish a high price from a low price that will result in rapid acceptance of the new product. Another implicit assumption is that competitors will be quick to recognize a high price.

All of this is unrealistic for a number of reasons. First, both the producer of the new product and those who might be lured into competition will be concerned with profits over a period of years. No one is so naive as to think that initial offering prices won't change. For this reason, the supposed effect of a high price in encouraging competition, or a low price in discouraging competition, can be discounted. Profit-minded business managers are going to look at the long-term picture.

Second, the concept of a high price or a low price can exist only with respect to a base line. Here, the base line is the cost of producing the new product. At the outset of commercial production, no one can be certain about the cost of production. No one can be sure of sales volume. As experience is gained, engineering and production techniques are constantly improving, and costs are reduced.

For example, in the early days of the electric blanket, one of the elements of cost was a relatively expensive transformer that changed the higher voltage house current to the lower voltage on which the electric blanket operated. Subsequent production techniques lowered costs by eliminating this expensive transformer so the blanket could operate at the voltage of the household supply.

Third, the volume factor creates another unknown element in calculating profitability. Sales volume is the multiplier of the profit margin. It determines total profit levels.

► Pricing Strategy

The objective is to establish a price within a range where sales wouldn't increase substantially if prices were lowered, and would fall off rapidly if prices were raised, Fig. 2.

It's generally assumed that as unit selling prices are increased, sales volume falls off proportionately,

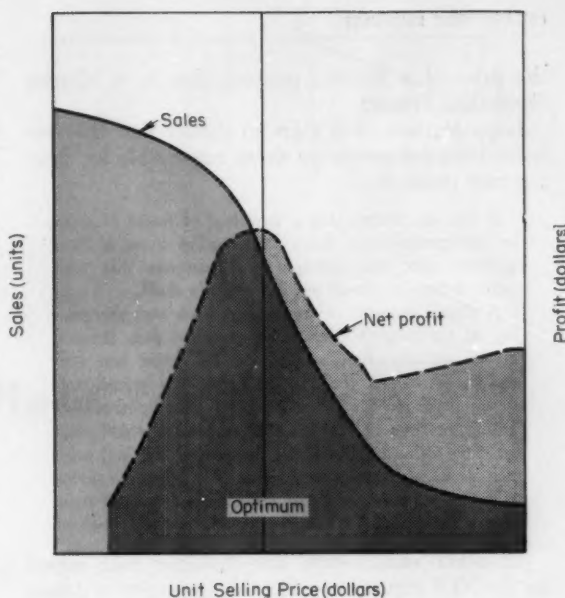


Fig. 2—Price-profit optimum is the target in pricing strategy.

and as unit selling prices are decreased, sales volume increases proportionately.

If this were true, pricing would be a simple matter. One would merely find the point where price-profit-relationships are optimum by calculating potential sales volume for each different price increment. As unit prices are increased, the assumed volume decrease would increase unit costs and decrease unit profit, thereby offsetting increased price.

It isn't safe to assume that sales volume will respond to price changes according to this model. Experience has shown that price changes sometimes have directly opposite effects than those that might be assumed. The pricing of either consumer or industrial products at too low a level may result in their being regarded as inferior products by potential customers.

By increasing the price per yard of a particular fabric twenty times its original price, the fabric was moved from an economy product category to a prestige product category with a substantial increase in yardage sales volume and an even greater increase in dollar volume.

► Nearest Equivalent Product (NEP)

The important point in pricing is to determine, in advance, the value the customer will place on the product. This approach may not appear objective, but it can't be denied that the customer is the one who decides to buy or not to buy. The price of a new product, to be realistic, must be constructed from the customer's viewpoint.

A helpful guide is to recognize that the customer is a comparison shopper. Regardless of product, the customer will compare your price with

the price of a familiar product, that is, a Nearest Equivalent Product.

Some of these NEP's are so similar that they require little guesswork by those responsible for pricing new products.

If you are introducing a new loaf of bread of more or less conventional grade and quality there is little question that the customer will compare this with other loaves of bread on the grocer's shelf.

A classic example of some years back was the pricing of the original Reynolds ball-point pen. Because of the unique advantages of the ball-point pen over the fountain pen, the ball-point pen was priced considerably above the better fountain pens on the market at the time. It was felt that customers would place an extra value on the added features of the ball-point pen. It was further assumed that in a war-time period when novel gift-type items were scarce, the ball-point pen with its unique features would be highly valued.

In other cases, what the customer will regard as the NEP requires considerable ingenuity to detect.

If you are pricing a new kind of sailboat to be sold to a market made up of those who haven't been able to afford the pleasure of sailing, the NEP your customer may use for comparison purposes might be the price he pays for golf during an entire season—a sport he might abandon for sailing.

If a direct-drive meter is being introduced to a manufacturer, his NEP concept may include his present power source, its components, and its cost of maintenance.

Determining the product the customer will establish as the NEP is the starting point in pricing new products. The next step is to position the new product relative to this nearest equivalent on a value scale.

► The Pricing Profile

Once an idea for a new product has been related to its nearest equivalent from the customer's viewpoint, it must be related to its nearest equivalent on a performance and group appeal scale.

Assume that a battery-operated electric clock is to be introduced. Potential customers will immediately compare this proposed clock with other clocks on the market. The NEP is already established, but there are two more questions: 1. Will the proposed product offer better performance? 2. To what customers will the product have greatest group appeal?

From a pricing position, performance and group appeal measures give the best guidelines possible. They are not as exact as engineers would like, but they do point a direction.

In the case of a battery-operated clock, there are a number of alternatives. It will be unnecessary to limit the location of the clock to nearby electrical outlets. Here are many advantages. Mounted on the wall, there would be no unsightly wire dangling from the clock. A small clock could be carried as a travel clock. It would operate continuously.

Beyond these advantages, the product concept might be adapted to a chime clock. Further, a clock might be designed to show days of the week, month of the year, the date, and the phases of the moon. An alarm might wake us up and a recorded voice tell the time and turn on radio or television.

At the opposite extreme, the design might be greatly simplified if there is a market for a very low-price clock. Certain products may appeal to different markets at different points along both the prestige scale and value scale.

A single product price might be high in the consumer market and low to industrial customers.

Examine another idea for a new product—a device that would indicate temperature at a remote point. Such a device might consist of two units. One would have a temperature-indicating scale and could be mounted on any wall since no wiring would be required. The other unit, also self-contained, could be placed anywhere within a radius of 1000 ft of the indicating unit. This second temperature sensing and transmitting unit could be located either indoors or outdoors. At a glance, the owner of this device could tell the temperature at the point where the transmitting unit was located. Fifty feet of waterproof wire attached to the sensing unit would enable the temperature sensing element to be located under water, underground or in a processing bath.

A product of this type might be expected to have two markets—industrial and consumer. In the consumer market, this product would take on a definite prestige character at a high price. It might be used by an estate owner to indicate the temperature of a lake. Or it might be used at some open spot on the property to indicate the prevailing temperature. The indoor-outdoor thermometer would be its NEP.

As an industrial item in a market where similar products are already used, the device might be developed to be priced far below existing equipment of a similar nature.

The two scales, performance and group appeal, used in making the price profile, are also useful in positioning price with reference to the nearest equivalent product.

► What's It Worth?

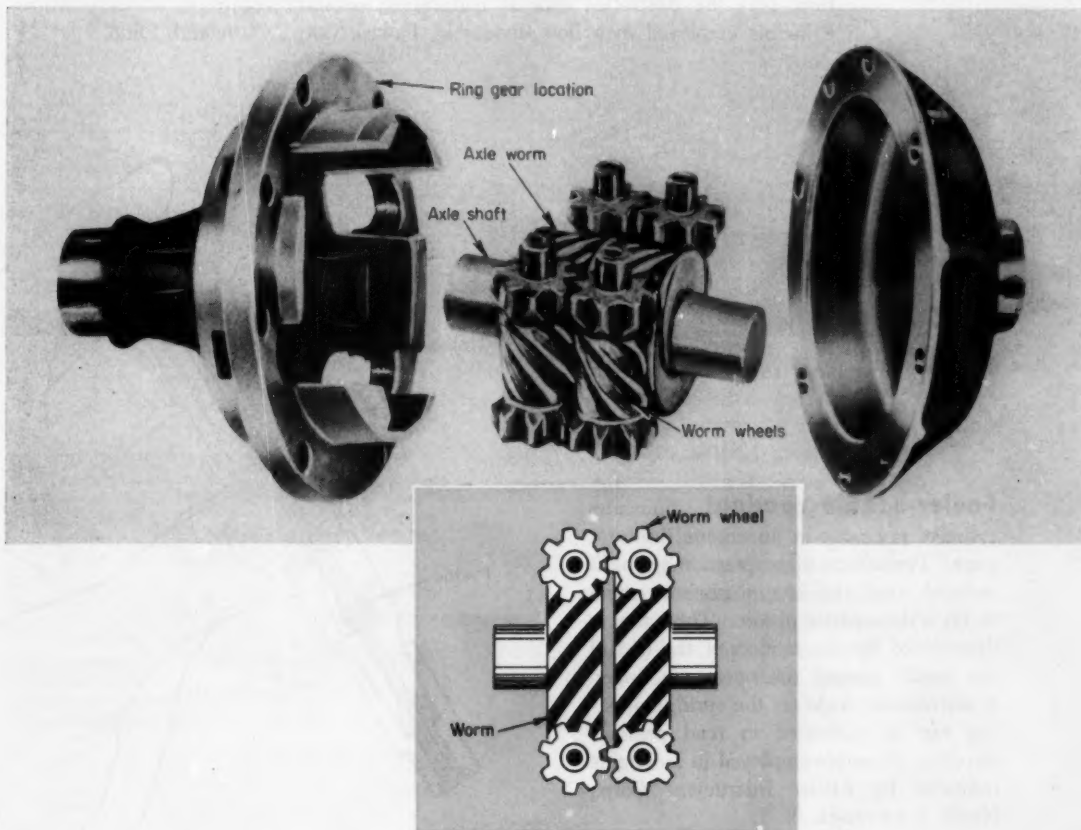
It may be disturbing to come this far and to hear no mention of cost. But what does cost have to do with price? Not much. The difference between price and cost is profit, but price and cost aren't directly related. Their makeup involves different factors.

A producer of a product may have a number of objectives. He wants to establish acceptance of the product. He wants to recover his development and production costs. He wants to make a profit. He wants both a long-range and a short-range profit. He wants the product to increase the acceptance of his other products. He wants to discourage competition.

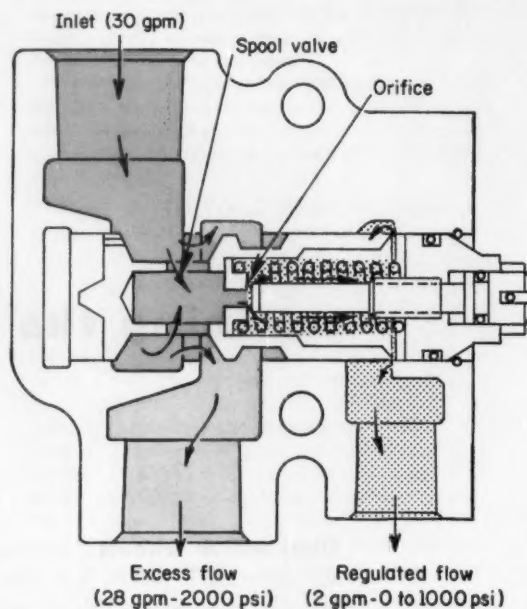
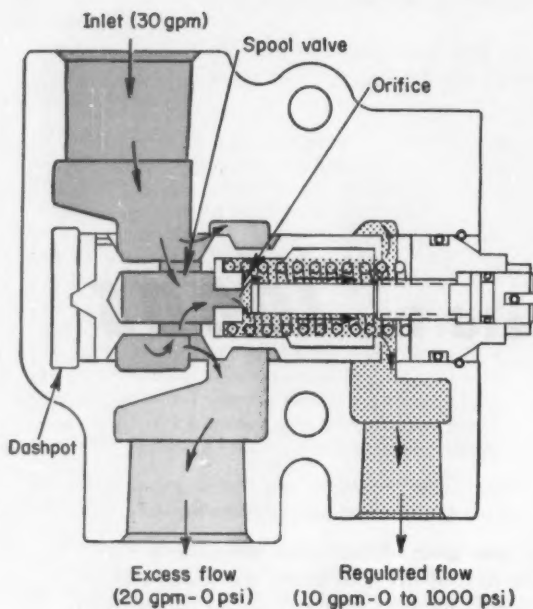
To price a product realistically, the primary objective must be to determine the values which consumers will attach to the product. Any attempt at a pricing decision based primarily on the desires of the producer results in frustration. Price is determined by the customer on the basis of his own answer to the question "What's it worth?"

scanning the field for *ideas*

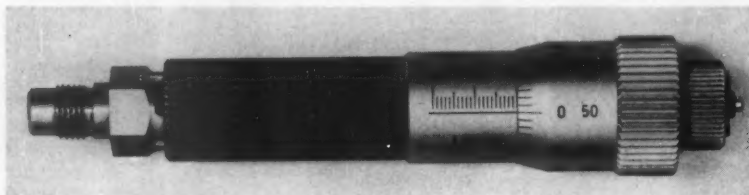
Dual worm wheels, connected by spur gears, divide input torque in a non-slip differential. When both axle shafts turn at the same speed, the worm wheels function as stationary driving keys. When the axles turn at unequal speeds, the relative motion between the slower turning axle worm and its corresponding worm wheel produces a rotational force which is transferred through the spur gears to the other worm wheel. Principle employed in a torque-proportioning differential by Dual Drive Inc., Cleveland, Ohio.



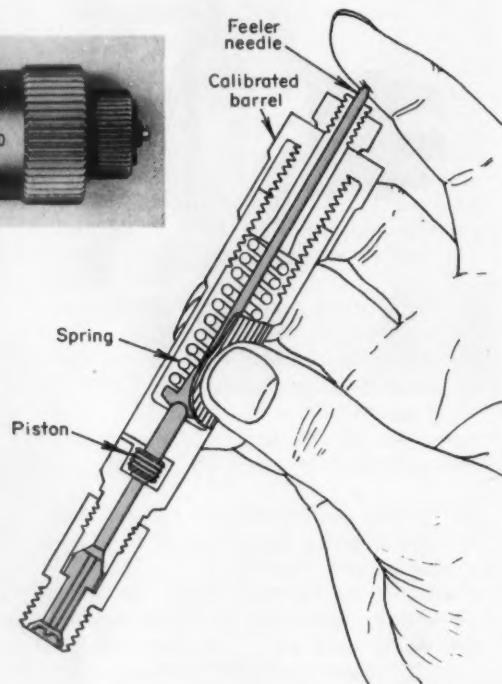
SCANNING THE FIELD FOR IDEAS

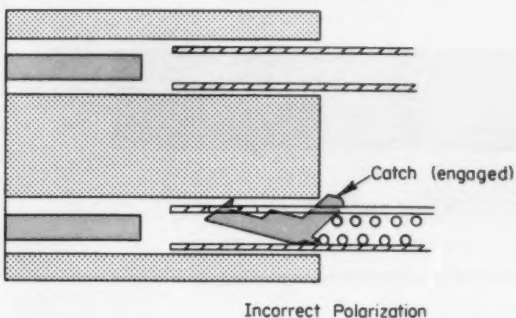
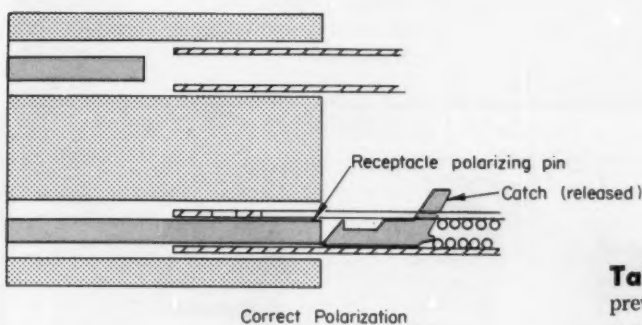
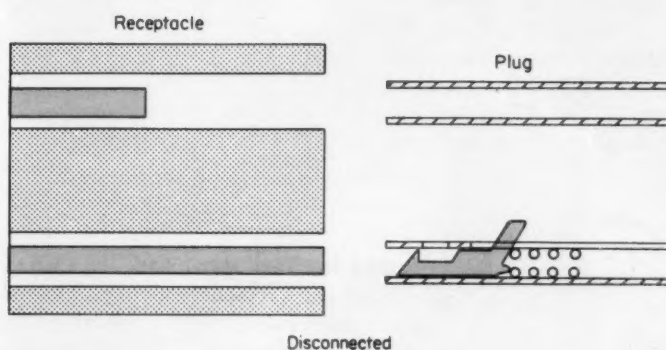
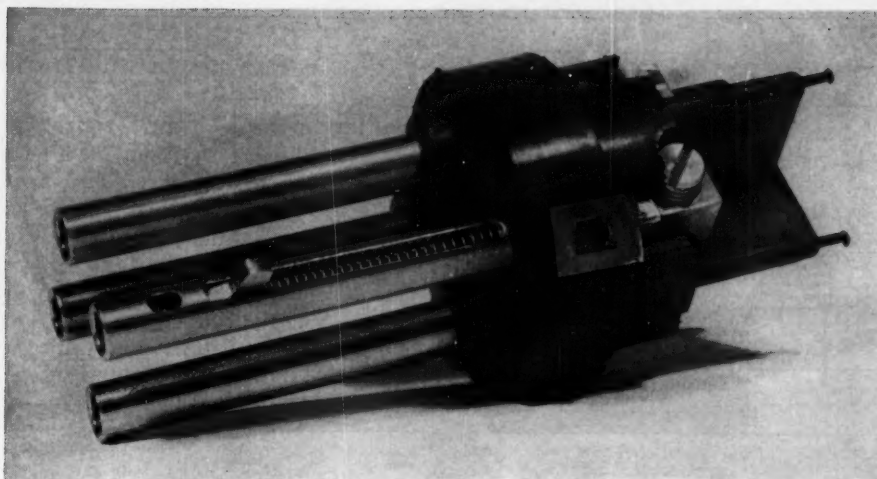


Two rates of flow are available at the excess-flow port of a flow divider. A pressure-controlled orifice positions the spool valve to decrease the flow to the regulated port and increase the flow to the excess-flow port when pressure increases on the excess-flow port. When the pressure is removed from the excess-flow port the controlled flow is maintained constant regardless of its pressure. Principle employed in a flow divider by Fawick Corp., Cleveland, Ohio.



Feeler-needle readout indicates cylinder pressures in an engine indicator gage. Preload on a compression spring is reduced until the engine pressure starts to lift a differential piston. This point is determined by the motion of the end of the needle against the operator's finger. A micrometer scale on the spring-adjusting nut is calibrated to read pressure directly. Principle employed in an engine indicator by Kistler Instrument Corp., North Tonawanda, N. Y.

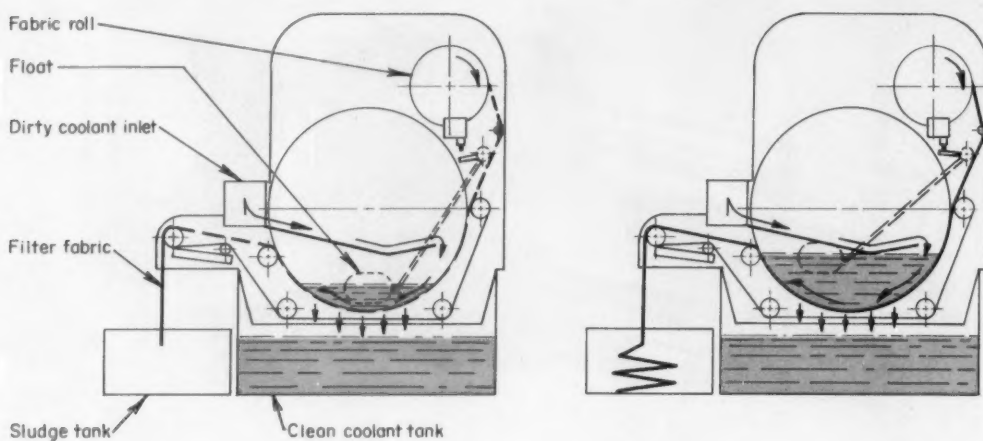




Tab-actuated catch

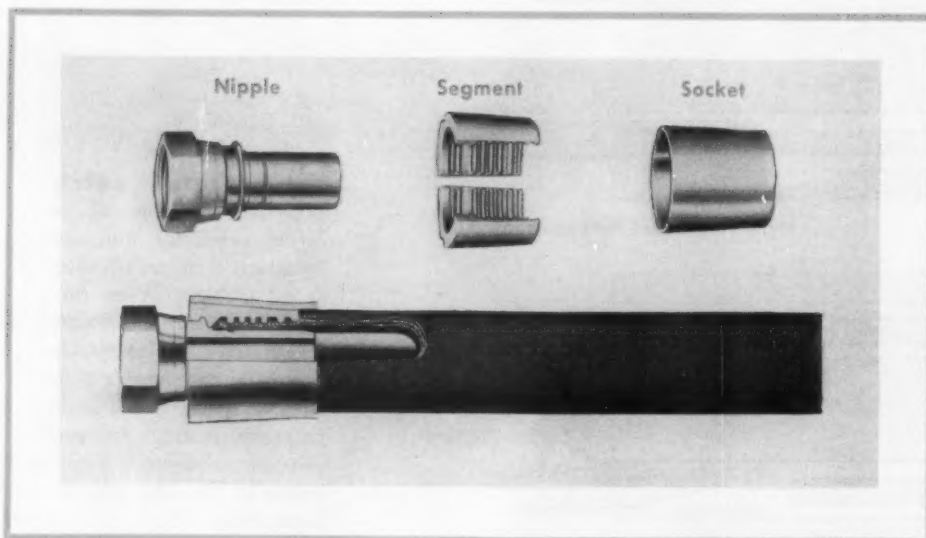
prevents insertion of a power connector into the receptacle if the polarization is not correct. When correctly inserted, the extra length of the receptacle polarizing pin permits it to push the spring-loaded catch past the locking position. Principle employed in a connector by Joy Mfg. Co., St. Louis, Mo.

SCANNING THE FIELD FOR IDEAS

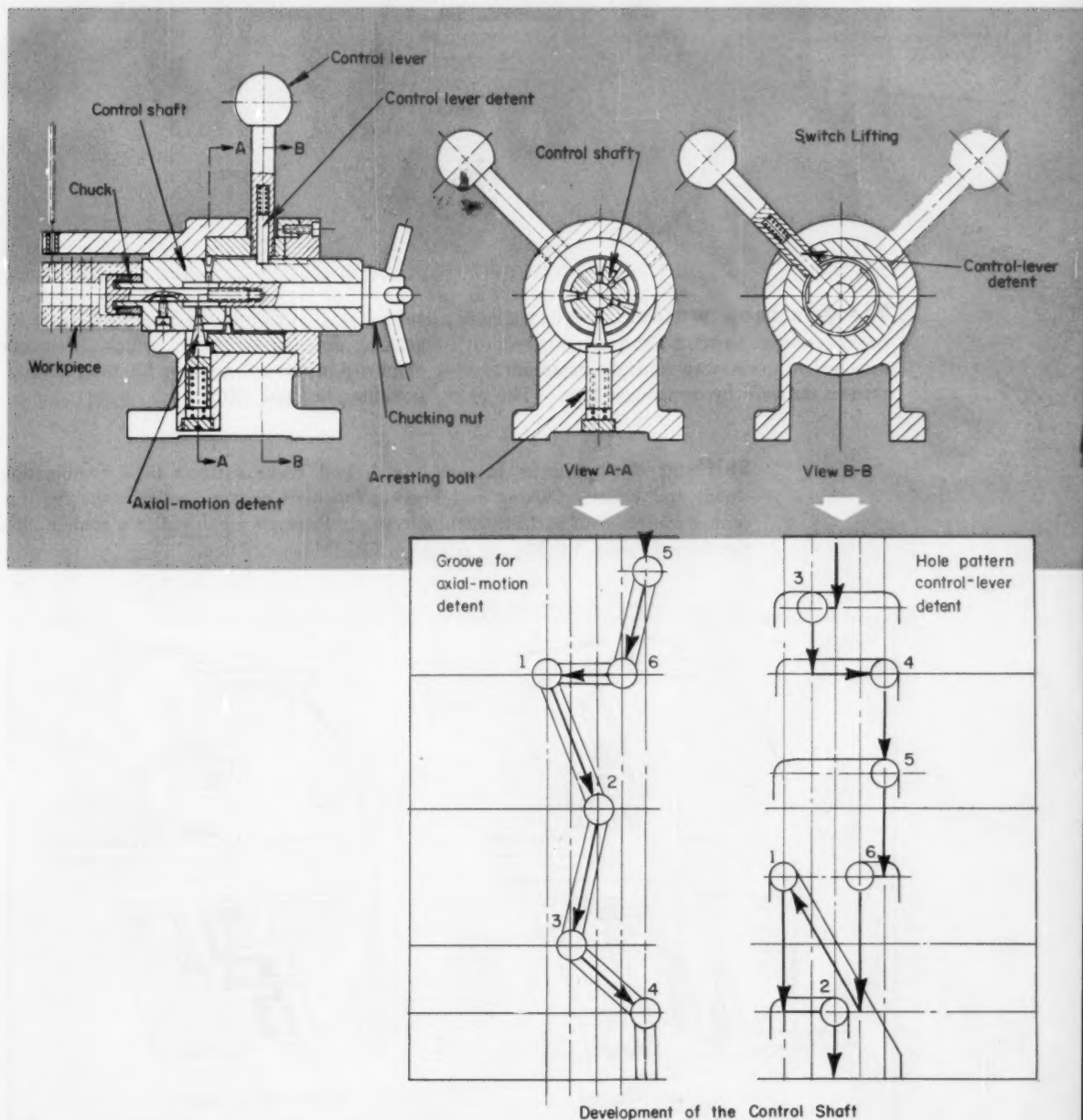


Fluid depth controls movement of expendable fabric in a coolant filter. Incoming liquid sags the fabric to form a pool. When the contamination causes the pool level to exceed a preset value, a float-actuated switch operates the drive motor to feed clean fabric into the pool area. Principle employed in a filter by Barnes Drill Co., Rockford, Ill.

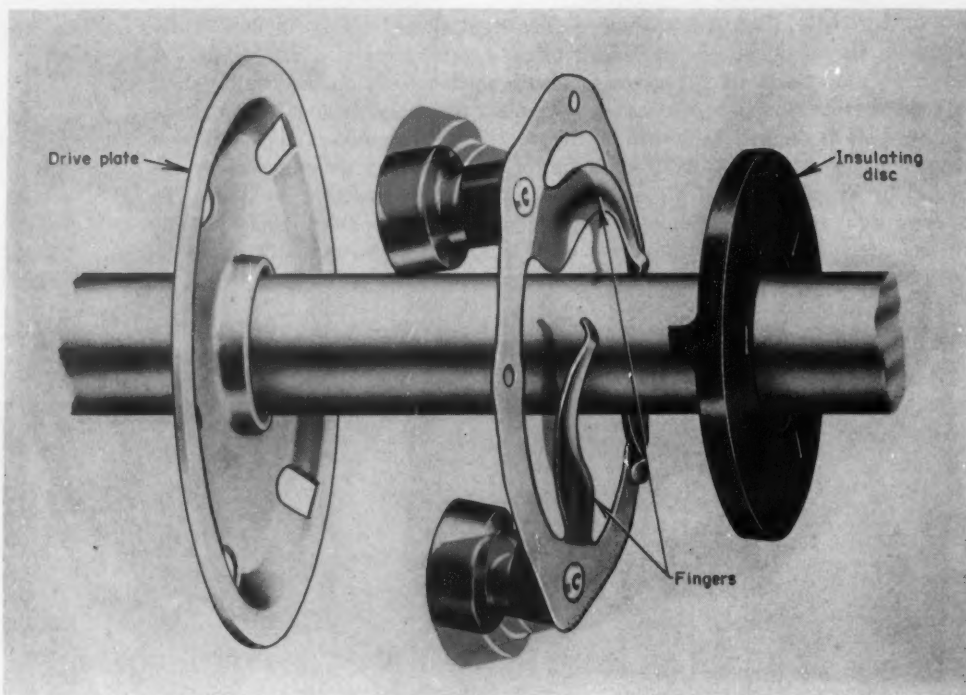
Wedge-locked grooves grip hose walls to form a reusable coupling. Tapered socket pressed over grooved segments during assembly compresses the hose wall between the nipple and the segments. Principle employed in a hose coupling by Aeroquip Corp., Jackson, Mich.



Co-ordinated detents produce combined axial and rotary motion in response to simple side-to-side movement of the control lever of a drilling jig. A detent in the control lever engages successive ratchet teeth on the control shaft to produce rotary motion. A second detent engages holes arranged around the control shaft in the pattern desired on the workpiece. To produce an axial motion component when the control lever is operated, the second detent, partially retracted by a cam, serves as a guide pin in the grooves connecting the holes. To produce axial movement without rotary motion, the control-lever detent engages an axial cam face on the drive ratchet. Principle employed in a drilling jig by De Limon Fluhme & Co., Duesseldorf, Germany.



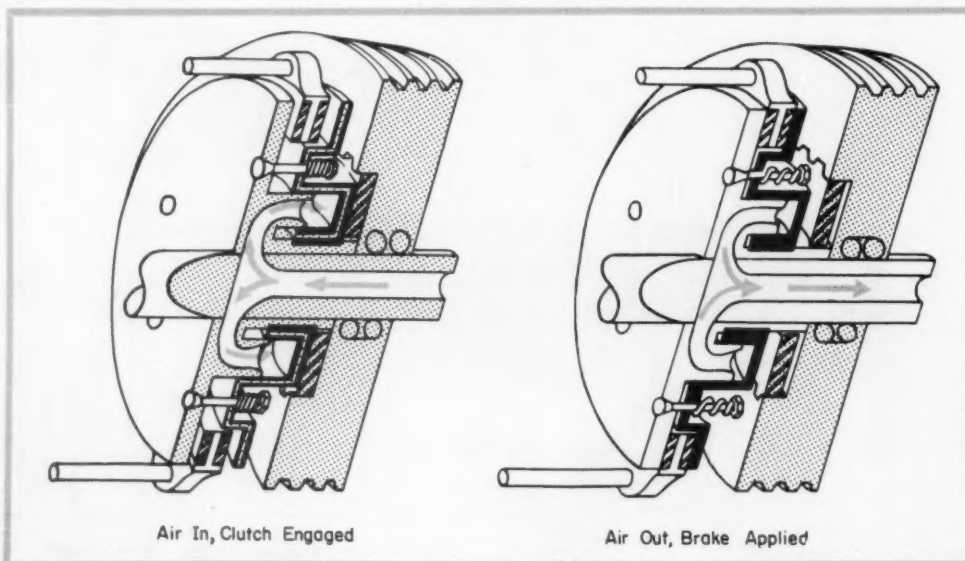
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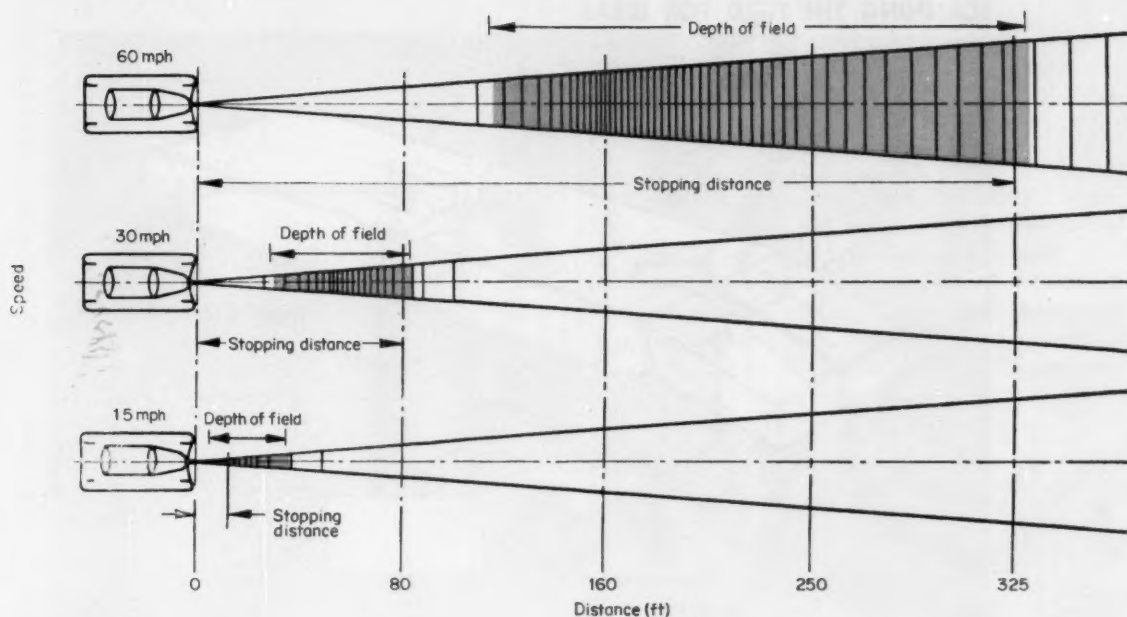


Weights snap washer to actuate a speed-sensitive switch. The weights, rigidly attached to a cutaway conical disc spring, are thrown outward by centrifugal force. The re-

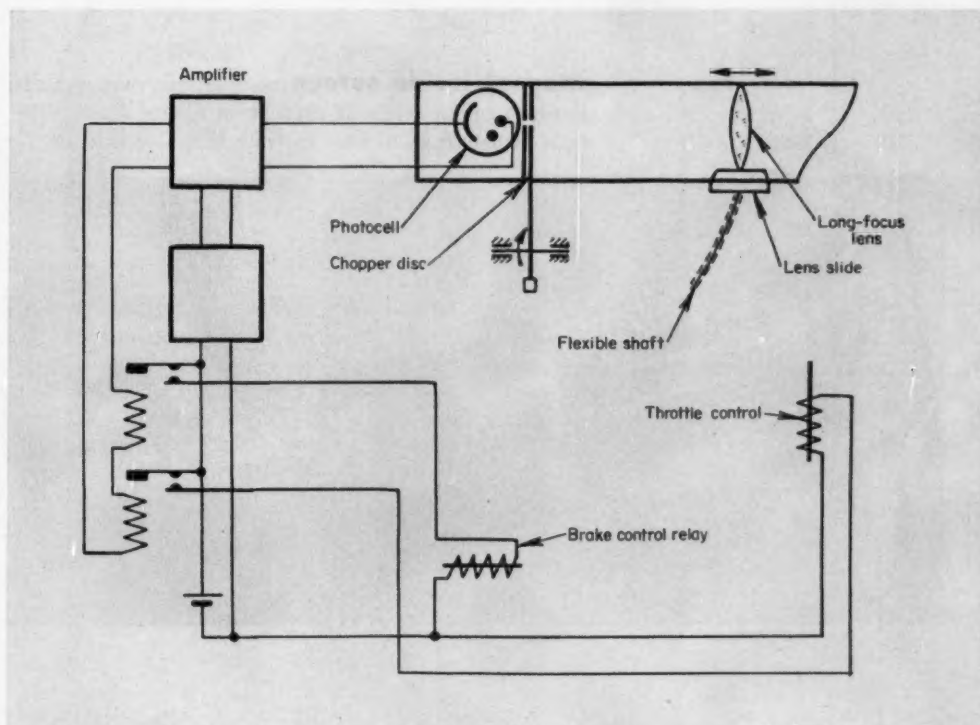
sulting axial motion of the fingers moves an insulating disc to operate the switch. Principle employed in a switch by Torq Engineered Products Inc., Bedford, Ohio.

Shifting disc shuttles between clutch and brake surfaces in a combination clutch and brake. Driving and braking functions cannot overlap since the disc cannot contact both surfaces simultaneously. Principle employed in a combination clutch and brake by Minster Machine Co., Minster, Ohio.

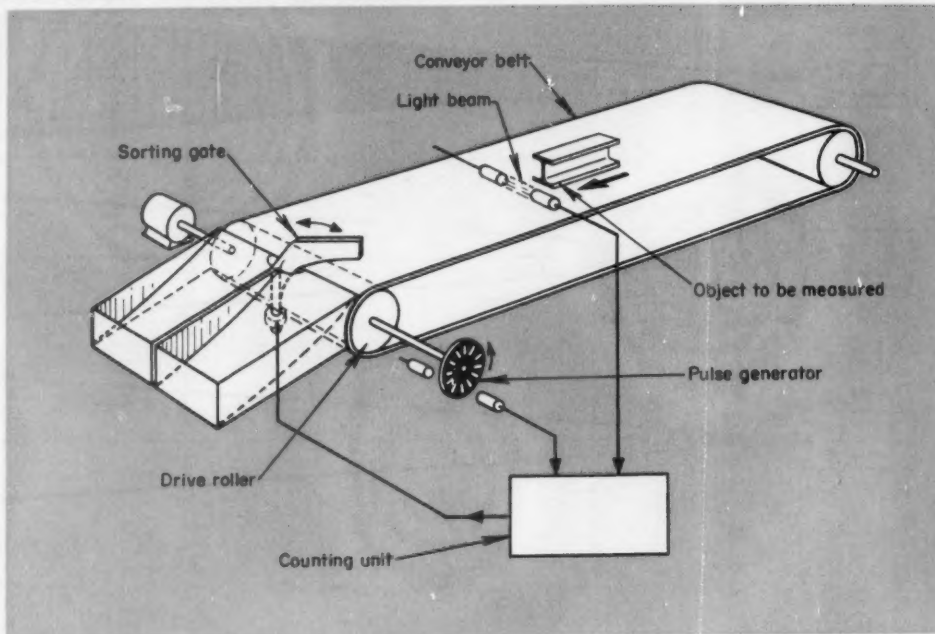




Speed-sensitive optics control brakes and throttle in an automobile safety device. Position of a long-focus lens is controlled by an input signal from the speedometer. Reflected light from any obstruction entering the field of the lens passes through a perforated disc chopper to produce pulse output from a photocell. The output is amplified to first apply the brakes and then close the throttle. Principle in a control device designed by Robert Bosch GmbH, Stuttgart, Germany.



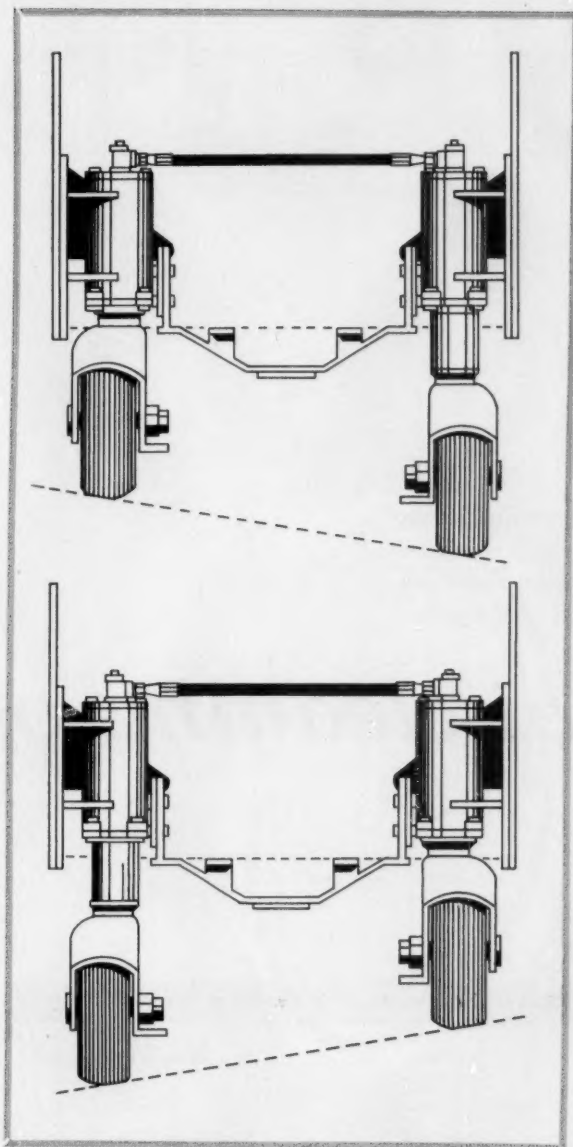
SCANNING THE FIELD FOR IDEAS



Pulse-controlled gate measures and sorts objects on a conveyor belt. A pulse generator is mechanically connected to the conveyor drive drum. Total pulse count during traverse of the object through the interrupted light beam controls position of the sorting gate. Principle employed in sorter by Allgemeine Elektrizitäts-Gesellschaft, Berlin, Germany.

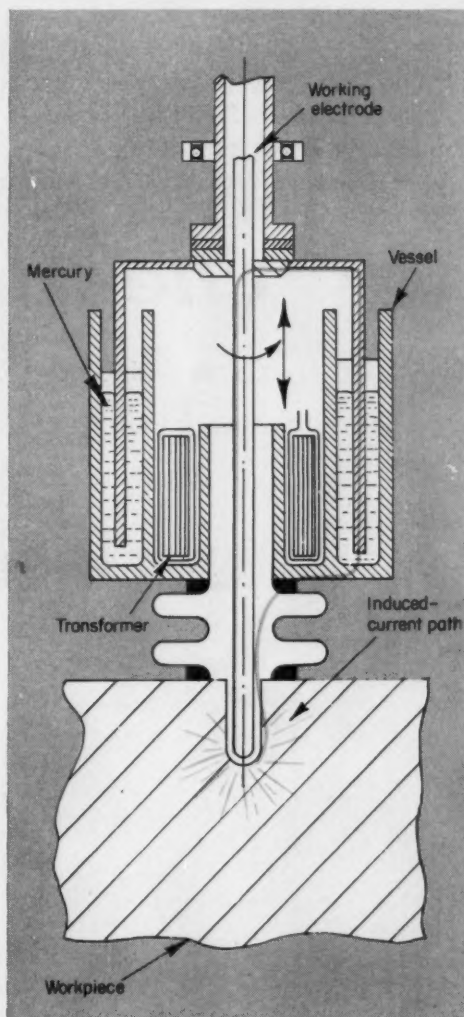
Magnet inside screen occupies otherwise waste space to collect magnetic particles in filtered fluid. Principle employed in oil filter by Eriez Mfg. Co., Erie, Pa.





Hydraulically connected equalizers produce equal but opposite vertical travel of vehicle wheels. Thus, the conventional pivoted axle is not required to permit the wheels to adjust to changing ground contour. Principle employed in a lift truck by Motec Industries Inc., Hopkins, Minn.

Mercury-submerged cylinder serves as secondary of a movable coil transformer to permit adjustment of induced secondary current in a spark-erosion machine. Mercury completes circuit of secondary current. Amount of induced current is controlled by the amount of flux cut by the cylinder. Principle employed in spark erosion machine by Deutsche Edelstahlwerke AG, Krefeld, Germany.



Serviceability and visual appeal of a metal product often depend on its final finish. But before the finish can be applied, surfaces must be thoroughly cleaned. Here are basic selection considerations and process descriptions for . . .

chemical cleaning of

LESTER F. SPENCER

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Table 1—Contaminants Classified According to Difficulty of Removal

Easy to Remove		Difficult to Remove	
Rust Preventatives			
Mineral oil	Petrolatum Lube grease Mineral oil + polar additives	Lanolin	Fatty oils Asphaltic material Waxes
Metal-Forming Lubricants			
Soaps	Soluble oils Mineral oil + E.P. additives Emulsifiable compounds Sulfurized mineral oil	Pigmented emulsifiable compounds Pigmented oil-base sulfurized fatty oils	Fatty oils
Polishing Compounds			
Liquid buffing compound Soap burnishing compounds	Light grinding oil	Buffing compounds	
Paints and Carbonized Oils			
Linseed oil paints	Alkyds Zinc chromate primer Acrylics	Highly baked phenolics Epoxy resin modified alkyds Phenolic varnishes Epoxy resin modified phenolics Amine-catalyzed epoxy resin paints	
Solids			
Dry dirt Pickling smut Very light rust Light to moderate rust	Hard-water scale	Heat-exchanger scales Phosphate coatings Heavy rust	Mill scale



metal parts

SURFACE cleaning of a metal part is often more important than the finish itself. Without proper base preparation, serviceability of the finish may suffer. For any material, the cleaning specification should relate the type of contaminant involved, the cleaning method, and the cleaning compound.

Chemical surface-cleaning methods vary from simple, manual solvent-cleaning procedures to automated, multistage systems. In the more complex operations, cleaning methods such as vapor degreasing and solvent, emulsifiable-solvent, and emulsion cleaning are considered as precleaning treatments—where gross soils are removed. Alkaline cleaning is regarded as an intermediate cleaning step. Final treatments, for “chemically clean” surfaces, are accomplished by one of the electrolytic processes, often in combination with an alkaline cleaning solution.

► Basic Considerations

The choice of a chemical cleaning agent depends upon a number of factors. The most important of

these are:

1. **Nature of contaminant.** Of the many contaminants, some are more difficult to remove than others, Table 1¹. No single compound completely removes all types.
2. **Physical aspects of contaminant.** The soil may exist as a thin film or as a thick layer. A loose soil requires a light-duty cleaner; a more adherent soil, a heavy-duty, penetrating-type cleaner. Part design is also important. A simple, smooth-surfaced part is cleaned easier than a hollow, drilled, seamed, engraved, or embossed part. The more complex parts usually pick up more contaminant and hold it more tenaciously.
3. **Degree of cleanliness required.** Parts that are to be electroplated require a chemically clean surface. Parts to be phosphated and painted require only a physically clean surface.
4. **Part material.** Steel parts are not attacked by strong alkaline solutions. However, other materials such as aluminum, brass, and die-casting alloys require buffered or inhibited compounds which do not attack the base metal. For composite assemblies, the most active metal governs the choice of cleaner.

¹References are tabulated at end of article.

Since most metal-cleaning operations are performed either by a dip or spray process, the question of the most efficient method is the second basic consideration. It is immaterial whether this cleaning action is accomplished by dip or spray technique—provided that the contact is *intimate* and *turbulent*. Neither spraying nor dipping is a universal method. Most work can be dipped, but not all parts can be sprayed.

Design or shape of parts determines whether a dip or spray-cleaning procedure should be used. Shallow drawn parts, flatware, and sheet-metal parts are examples of pieces that can be sprayed effectively. Small parts, unless they are fragile or highly finished, can be handled in baskets and should be dipped.

With the spray method, both intimacy and turbulence of contact exists between the work and the solution at the point of impact—but no further. With the dip method, intimacy of the contact is insured, but turbulence—even when a means of agitation is used—is less than in the spray method. The more intimate the contact, the more thorough the cleaning; the more turbulent the contact, the faster the action.

► Cleaning Methods

Vapor Degreasing: Both cost and uniformity of soil removal are relatively independent of the amount of soil removed in a solvent-vapor system. Because there is no chemical activity between the parts and the solvent, parts are neither etched nor stained during processing. Also, since mechanical action is absent, fragile parts can be vapor-degreased safely. Good penetration of the solvent is obtained even in the deepest recesses. Basic vapor-degreasing cycles for various types of parts with different degrees of contamination are shown in Table 2.

Solvents commonly used in vapor-degreasing systems are:

- Stabilized trichlorethylene. Used for cleaning of parts made from steel, copper, brass, zinc, aluminum, magnesium, and many other metals and alloys.
- Stabilized perchlorethylene. Used for metal drying, and preferred for cleaning of aluminum-base alloys where breakdown of trichlorethylene solvent may occur.

Where temperature limitations or corrosion problems are governing factors, other solvents in addition to these two may be considered, Table 3².

Solvent contamination is a critical control factor in a vapor-degreasing system. Recesses or pockets within the part can carry into the cleaning system reactive materials, oxidizing agents, or cyanide-bearing solutions that may react with or degrade the solvent. Water, if present in sufficient amounts, may cause hydrolysis and produce undesirable acid radicals. Thus, parts must be adequately rinsed to remove these water-soluble or reactive materials by dilution, and racked to permit thorough drainage. Also, the design of parts can often include provisions for drainage without functional interference.

Table 2—Vapor Degreasing Systems

Process Description	Remarks
Vapor System Work is suspended in solvent vapors. Vapors condense on cool metal surfaces. The condensed solvent dissolves greasy contaminants and drips back in solution tank.	For removal of soluble oils and greases. Weight and specific heat of work must be such that sufficient vapor is condensed to remove soil efficiently. Small, thin sheets would not be cleaned efficiently since insufficient solvent vapor would condense on the surfaces.
Warm Liquid + Vapor Work is immersed in warm liquid solvent, then suspended in solvent vapors.	Effective for heavy, soluble contaminants on light-gage parts. Also for intricate or nested parts that require intimate contact with the cleaning medium. Impractical for large sections that require an excessive amount of liquid solvent.
Boiling Liquid + Warm Liquid + Vapor Work is immersed in boiling liquid solvent, then cooled in warm liquid solvent, then rinsed in the vapors of the boiling solvent.	Generally the same as Warm Liquid + Vapor.
Vapor + Spray + Vapor Work is suspended in solvent vapors, sprayed with warm liquid solvent, then rinsed in solvent vapors.	Suitable where contaminant is only partially soluble. Vapor condensate removes soluble soils, leaving insoluble constituent intact. Spray minimizes setting or baking of insoluble soils. Residue is usually removed by another cleaning process. Not suitable for closely nested parts such as rivets, bolts, nuts, washers, and screw machine parts, but excellent for large parts.

Table 3—Applications for Vapor Degreasing Solvents

Application	Solvent	Vapor Temp. (F)	Selection Factors
Removal of soluble soils	Trichlorethylene	188	Most commonly used degreasing solvent.
Removal of slightly soluble (high-melting) soils	Perchlorethylene	250	Used where high operating temperature is required.
Removal of water films	Perchlorethylene	250	Provides rapid and complete drying.
Cleaning coils and other electric-motor components	Methyl chloroform	165	Solvent must not damage wire coating or sealing agents. Requires special equipment design. Selection should be based on preliminary trials.
	Trichlorotrifluoroethane	118	
	Perchlorethylene	250	
Cleaning temperature-sensitive materials	Methylene chloride	104	For low-temperature cleaning of parts.
	Trichlorotrifluoroethane	118	
Ultrasonic cleaning	Trichlorethylene	188	For high-quality cleaning of parts. Continuous distillation and filtration of solvent required. Selection should be based on preliminary trials.
	Perchlorethylene	250	
	Methylene chloride	104	
	Fluorinated hydrocarbons	118	

Cleaning Methods for Four Basic Types of Contamination

Contaminant	Vapor Degreasing	Solvent Cleaning	Alkaline Cleaning	Emulsion Cleaning	Electrolytic Cleaning
1 Pigments such as lime, chalk, talc, lithopone, sulfur, and graphite (common components of commercial drawing compounds). Difficulty in cleaning is due to inert nature of pigments. Organic portions are soluble or emulsifiable. When compound hardens and forms a crust, it is difficult to penetrate with some commercial cleaners.	Not recommended for these soils. Organic material dissolves and leaves the pigmented material adhering tightly to the surface, making subsequent cleaning more difficult.	Loosens these soils so they can be removed by subsequent emulsion or alkaline cleaning. Presoaking or solvent wiping is used for softening hardened or heavy deposits.	Most economical method of removing these soils. Soak-type cleaning, even with violent agitation, is less effective than spray cleaning. Lower concentrations of chemicals are required for spray cleaning as compared to either soak or electrolytic types.	Both stable and multiphase emulsion cleaners perform satisfactorily immediately after parts are drawn or after aged deposits have been loosened by previous operations. Multiphase emulsions are more effective on caked soils and may be applied either by immersion or spray.	Most effective and most expensive method of removing these soils. Precleaning is recommended to remove gross soils. Electrolytic cleaning should be used when parts are to be electroplated.
2 Oils, greases, and various types of unpigmented drawing compounds.	A quick and effective method to remove these soils. Parts emerge clean and dry. Mechanical action, such as spray cleaning, is required to remove loosened solid particles.	Not recommended for these contaminants.	Most economical way to remove these soils. Used hot to saponify or emulsify the soil. Heavy soils require soak cleaning. Spray cleaning requires low-foam cleaners.	Effective in either soak or spray-type operation. More expensive than alkaline cleaners, but may be used at lower temperatures. A corrosion-resistant film remains on parts after they are processed.	Necessary for parts that are to be plated. Anodic cleaning used in most applications; however, some soils require a combination anodic-cathodic cleaning. Cost must be justified by the need for high-quality work or because other methods are unsuitable.
3 Cutting and grinding fluids including: Group 1 —Plain and sulfurized mineral and fatty oils, chlorinated mineral oils, and sulfurized chlorinated mineral oils. Group 2 —Soluble oils (either conventional or heavy-duty type) with sulfur or other additives, and soluble grinding oils with wetting agents. Group 3 —“Chemical” cutting fluids which are water soluble and generally act as cleaners. They contain soaps, amines, sodium salts of sulfated fatty alcohols, alkyl aromatic sodium salts of sulfonates, or other water-soluble agents.	Dissolves and removes Group 1 soils easily. Soils within Groups 2 and 3 may not be removed completely, and may cause deterioration of the solvent and subsequent lower efficiency due to water contamination.	Preferentially removes cutting fluids of Group 1. However, reprecipitation of soil onto the work surfaces may occur.	Effective in removing all three groups of soils.	Removes all groups of cutting fluids. The process is inexpensive and the fire hazard is low. A thin, organic film remains on the work and provides some protection against corrosion. Frequently used as in-process cleaner. Surfaces of cleaned work are usually satisfactory for subsequent painting or phosphating.	Required to obtain chemically clean surfaces for electroplating. Electrolytic cleaning often follows emulsion cleaning.
4 Polishing and buffing compounds. The soil is usually composed of burned-on greases or metallic soaps and waxes, further contaminated with fine particles of metals and abrasives. (Selection of a buffing or polishing compound with good cleaning characteristics is desirable.)	Dissolves organic materials, but may not affect residues. Difficulty increases as the residues cake. This method is not used too frequently, unless it immediately follows polishing or buffing.	With petroleum solvents, removes most of gross soil. Mechanical action such as brushing, swabbing or spraying is required.	Relatively slow in removing these soils. Effectiveness of soak cleaning can be improved by the addition of a soap or other surface-active agent to the alkaline solution. Brushing usually required.	Satisfactory if chemical cleanliness is not required. Presoaking in undiluted emulsion cleaner improves action of loosening encrusted deposits.	Produces best results in removing these soils. Cathodic cleaning can be used; however, because metallic and nonmetallic particles are deposited on the parts, a reversal to anodic cleaning is recommended. Even with this method, inert soil particles often must be brushed from crevices.

Solvent Cleaning: Petroleum solvents or chlorinated hydrocarbons are usually used in solvent-cleaning systems to remove such soils as mineral or vegetable oils. The petroleum solvents are distillates having sufficiently high flash points to permit their use at room temperatures. They are less expensive and less toxic than chlorinated hydrocarbons, but they are a fire hazard and must be handled accordingly. The equipment used is simple—usually a container for solvent to permit soaking of the parts, and wiping

cloths or a brush for manual removal of the contaminant. Solvent cleaning does not produce a high degree of surface cleanliness.

Alkaline Cleaning: The removal of soils by alkaline cleaning is accomplished by a detergent action. This action is the result of a series of physical processes even though it is performed with materials classed as chemicals.

The primary mechanism of soil removal by this

method is that of wetting the surface. The detergent solution must also loosen the adhering soil. Penetration is controlled by the degree of alkalinity of the solution and by the addition of suitable colloidal materials such as soap or synthetic detergent.

The second soil-removal mechanism consists of emulsification and dispersion of the contaminant by the combined action of the cleaner, solution agitation, and heat. The low interfacial tension of the cleaning solution promotes contact and penetration; agitation overcomes adhesive forces between individual particles; heat melts fats or reduces viscosity of oily residues. The soil is displaced from the surface and dispersed throughout the solution as a finely divided suspension.

The final mechanism of soil removal by alkaline cleaners is a reuniting of the suspended particles into an aggregate that either precipitates from solution or floats on the surface and can be skimmed off.

Properties of an efficient alkaline cleaner, in order of importance, are: 1. Dissolving power (high alkalinity). 2. Dispersing power for solids. 3. Emulsifying power for liquids. 4. Rinsability. 5. Low surface tension (wettability). 6. Stability. 7. Good conductivity (in the event of their use in electrolytic operations). 8. Effectiveness in low concentrations (for economy). 9. Freedom from toxicity.

To be fully effective, an alkaline cleaner must be tailored to remove a variety of solid and liquid contaminants, and also be compatible with the material being cleaned. One method of classification is by the pH value of the cleaner. Strong alkaline compounds used for cleaning steel have a pH of 12.4 to 13.8. These are the heavy-duty cleaners. Materials such as aluminum, brass, and die casting alloys require an alkaline cleaner that is buffered or inhibited. The pH value of buffered cleaners varies from 11.2 to 12.4—the light-duty range. For metals that corrode or tarnish easily, cleaners within the "soft-metal" range of 10.5 to 11.2 pH are used.

Typical alkaline formulations for various metals consist mainly—88 to 99 per cent—of builder components which provide the required alkalinity and other desirable properties at relatively low cost. Surface-activating agents (surfactants) make up the balance. These latter components improve the efficiency of the cleaning operation by serving as wetting agents to reduce both surface and interfacial tensions.

Sodium hydroxide is a commonly used builder ingredient and, although it maintains high alkalinity when used on acid soils, it is not considered as effective a cleaner as the alkali silicates. Sodium hydroxide is a poor wetting agent and is difficult to rinse; the alkali silicates display good wetting and emulsifying properties. Consequently, anhydrous sodium metasilicate is used in many formulations for general-purpose cleaners and in those for metals such as aluminum, magnesium, and zinc because the silicate film inhibits excessive alkali attack.

Both the silicates and the phosphates serve as

Table 4—Principal Alkaline Cleaning Cycles

Cycle	Time (min)	Temperature (F)
Soak		
Clean	3 to 5	160 to 212
Cold rinse	¼ to ½	.....
Hot rinse	¾ to 2	160 to 200
Air dry	1 to 3	160 to 220
Spray		
Clean	¼ to 1	130 to 170
Cold rinse	up to ¼	.....
Hot rinse	up to ¼	130 to 160
Air dry	¼ to 1	160 to 220
Electrolytic*		
Clean	¼ to 1	160 to 210
Cold rinse	¼ to ½	.....
Hot rinse	¾ to 2	160 to 200
Air dry	1 to 3	160 to 220

*Usually preceded by a soak or spray cleaning. Electrolytic cleaners are seldom operated below 180 F.

buffers and assure a uniform cleaning action. The silicates show a buffering action between pH values of 9 to 11.5, and the phosphates, between pH values of 8 to 11. The phosphates are also used for their water-softening ability.

Increased surface activity of cleaners is obtained by the use of soaps and synthetic detergents (syndets). Other surface-active agents are also used to promote faster cleaning action by decreasing surface tension and by breaking down of interfacial tension.

Alkaline cleaners are composites in which silicates, phosphates, carbonates, detergents, soaps, and wetting agents are formulated that may or may not have caustic soda (sodium hydroxide) as an ingredient. Basic cycles for alkaline-cleaning methods are given in Table 4³.

Emulsion and Diphase Cleaning: Three types of emulsion cleaners are commonly used: 1. Emulsifiable solvent. 2. Stable emulsion. 3. Diphase.

Emulsifiable solvent cleaners, which may be used either in the undiluted state, or diluted with a petroleum solvent, are effective in removing tightly adherent and heavy soils. These cleaners normally are operated at room temperature as immersion baths, followed by a hot-water spray rinse which removes the loosened soil. The rinse cycle eliminates contamination of subsequent alkaline cleaner baths.

The diluent in a stable emulsion cleaner is water. This type of cleaner simultaneously removes water-soluble and solvent-soluble oils. Because the diluent is not a hydrocarbon, stable emulsion cleaners may be used up to 180 F. Although maximum effectiveness is obtained with a spray system, stable emulsions also perform well as soak-type cleaners. A stable emulsion has the ability to disperse a soil once it has been removed from a work surface, thus preventing redeposition on clean surfaces.

A thin, oily residue remains on the surfaces of parts after emulsion cleaning. This film is a mild rust preventive, and can serve to protect the parts

during short storage periods. Although the film is not detrimental for subsequent phosphating and painting operations, it must be removed from parts that are to be plated.

Emulsifiable solvent and stable emulsion cleaners consist of four basic ingredients: 1. An organic solvent—usually a hydrocarbon such as kerosene or naphtha—which comprises the major portion of a formulation. 2. An acid soap or fatty acid which serves as an emulsifying agent. 3. A blending or wetting agent, which provides a homogeneous and stable mixture of solvent and emulsifying agent. 4. A surface-activating agent to increase cleaning effectiveness.

Emulsification occurs when a diluent such as water is added to the emulsion concentrate. The two immiscible liquids are intimately combined as a stable solution in which the particle size of the dispersed-solvent phase varies from 1 to 10 μ in diameter. Reduction of particle size during emulsification and maintenance of the condition during the serviceable life of the solution is governed mainly by the surface-activating agent.

Diphase cleaners differ from emulsion cleaners in that two distinct phases are present upon dilution. One phase is the solvent, which may be either the heavier or lighter fraction; the second is water. The solvent removes the oils and wets the metal, and the water dissolves water-soluble contaminants and wets mineral oils. Since a diphase system permits a more intimate contact between the organic solvent and the surface soil, it is more effective than emulsion cleaning in deflocculating and suspending solid contaminants. On the other hand, since emulsion cleaners permit a more intimate contact than a water solution, they have greater detergent action than diphase cleaners.

Diphase cleaning also leaves a thin, oily residue on the work even after a hot rinse. The operating temperature of diphase cleaners is limited because of their relatively low flash points.

Electrolytic Cleaning: Because of efficiency in producing chemically clean surfaces, electrolytic cleaning methods are often used for parts that are to be electroplated. The generation of a large volume of gas in this type of system produces a mechanical action at the surface of the work. Proper choice of both current and operational procedure must be made to obtain maximum benefits.

One effective method, used for cleaning of small parts that may be tumbled without damage, utilizes the combined advantages of electrolytic action and mechanical tumbling action within an alkaline solution.

Cathodic cleaning, normally used on materials that are subject to anodic passivation, has the tendency to redeposit a thin metallic film on the work surface. When hydrogen absorption is detrimental to the end use of the product, cathodic cleaning should not be used.

Anodic cleaning, used frequently for cleaning steel and for zinc-base die castings, also leaves a thin, residual film on the work surface. A momentary acid dip will remove this film, however, and surfaces

so treated are chemically clean for subsequent electroplating. Substantial improvement in cleaning may be obtained with periodic reserve (PR) current.

Ultrasonic Cleaning: A transducer placed near the surface of the immersed work to be cleaned converts electrical vibration energy into mechanical vibration energy. The mechanical energy ruptures the fluid and creates a scrubbing action along the work surface. The result is a large increase in the removal rate of a surface contaminant.

Typical examples of ultrasonic cleaning are: 1. Removing lapping compound, chips, and cutting oil from honed ball-bearing races, using a mineral seal oil as the solvent. 2. Cleaning of automotive steering assemblies in trichlorethylene. 3. Cleaning of watch movements.

To efficiently use ultrasonic techniques, sufficient mechanical energy must be developed in relation to surface area exposed so that all surfaces can be reached. Cleaning can only be realized within those areas where the cleaning liquid can penetrate. Because of the relatively high cost of equipment, ultrasonic cleaning is only used where the required

Table 5—Typical Salt Baths

Bath Type	Temperature (F)	Description
Sodium Hydride (nonelectrolytic)	700-800	The bath consists essentially of a carrier salt, sodium hydroxide, and from 1.5 to 2.0 per cent sodium hydride. The salt functions as a reducing agent which converts the scale formation to a metal or to a lower oxide. Most of the loose scale is removed during a subsequent water quench.
Virgo (nonelectrolytic)	950	The bath is a mixture of caustic soda, sodium nitrate, and other chemicals. The action is oxidizing in nature, and oxide films are converted to a more soluble form. In the bath, surface scale swells due to the unequal expansion of the steel and the scale. The action causes slight cracks and separations in the scale which are intensified during the subsequent water quench.
Kolene No. 1 (nonelectrolytic)	825-975	This bath is an anhydrous oxidizing bath using a base of sodium hydroxide with additives to provide a controlled chemical oxidation. Inhibitors are used to prevent excessive caustic attack.
Kolene No. 4 (electrolytic)	825-975	This bath consists of an anhydrous sodium hydroxide base and other salt additives. When electrolytically activated, the bath forms reducing members at the cathode and oxidizing members at the anode. A 6 v dc source is required. When the work is anodic, the bath serves as an oxidizing unit; when the current is reversed, the work is cathodic, and the bath functions as a descaler.

cleanliness of a part cannot be obtained with other cleaning procedures.

► Removing Scale and Oxides

Removal of surface oxides may be accomplished by acid cleaning, chemical pickling, or by mechanical abrasion of the metal surface. Chemical pickling uses an acid solution or a molten salt. Another class of cleaners—acid cleaners—cleans and descales the material simultaneously.

Acid Cleaning: The phosphate-type acid cleaners remove light soil and light rust and provide a uniform, thin, inner film of insoluble metallic phosphate on the surface of ferrous metals. The film provides: 1. A good bond for subsequent paint coatings. 2. A base for retaining drawing lubricants. 3. Temporary protection against rusting.

The detergent type of iron phosphate system, particularly when used in spray equipment, is effective in removing mineral and rust-preventative oils.

Acid Pickling: The acids generally used in acid-pickling systems are sulfuric, muriatic, nitric, and hydrofluoric, or mixtures of these acids. Sulfuric acid is the most commonly used pickling agent because of its economy. Muriatic acid may be used for special purposes such as scale removal and surface etching prior to galvanizing and tinning. Nitric acid is used in pickling stainless steel and is occasionally employed to oxidize scaled surfaces. Hydrofluoric acid is an additive used to accelerate the pickling action or to remove sand from castings.

The action of a pickling solution varies approximately as the acid concentration up to a limiting value—about 25 per cent acid by weight. Since speed of reaction also depends upon immersion time and bath temperature, acid concentration may vary with these two factors.

Pickling inhibitors are agents which diminish the attack of an acid on a metal surface without appreciably retarding the rate of scale removal. An inhibitor frequently establishes the limiting temperature of a bath since some inhibitors fail rapidly at high temperatures.

Electrolytic pickling procedures decrease pickling time, reduce acid consumption, and can minimize hydrogen embrittlement when compared to standard pickling procedures. Anodic pickling may be used to mildly etch the surface of metal parts. This type of surface is satisfactory for the application of heavy electrodeposited or hot-dipped coatings. Where little or no metal removal is required, cathodic pickling is employed. However, one disadvantage of cathodic pickling is that hydrogen embrittlement may be equal to or greater than that resulting from still pickling. Conversely, anodic pickling minimizes hydrogen embrittlement.

Salt Bath Pickling: Both electrolytic and nonelectrolytic salt descaling baths are used to remove

Table 6—Hydrogen Pickup in Titanium Alloys

Alloy Composition, Balance Ti (per cent)							Hydrogen (ppm)
Al	Sn	V	Mn	Fe	Cr	Mo	
5.0	2.5	...	...	...	...	...	241
6.0	...	4.0	...	...	...	...	124
4.0	4.0	...	...	...	27
...	2.0	2.0	2.0	25
...	8.0	...	...	...	4
3.0	5.0	...	2

Results shown are for a 5 min immersion in a modified sodium-hydride bath.

surface oxides from common metals, refractory metals, and many of the corrosion-resistant alloys whose scale formation is impervious to acid-descaling procedures.

The high-temperature salt-bath soak is usually followed by a cold-water quench. The resultant steam blasts off the altered and loosened scale. To completely remove the last traces of scale, and to obtain a uniformly clean surface, the part is immersed in a hot-acid bath. Finally, the parts are rinsed to remove adhering acid and smut.

Any of several basic types of salt baths, Table 5, may be used for scale removal from any metal or alloy which does not react with fused caustic soda and whose physical characteristics are not adversely affected by either the bath composition or temperature. Typical of these materials are carbon and alloy wrought steels, stainless steels, copper, nickel-base alloys, cast iron, cast steel, and many of the refractory metals such as tungsten, molybdenum, and titanium.

The oxidizing (electrolytic anodic) baths have applications involving surface preparation other than descaling. They are also used to remove casting sand and investment materials from cored sections and holes, and to remove oils, greases, paints, and other oxidizable impurities.

Some advantages of salt-bath descaling methods are:

- Salt baths remove tight, adherent, oxide films that are very difficult to remove by acid-pickling solutions.
- Cycle times are short because of high operating temperature.
- Salt baths do not promote hydrogen embrittlement.
- Salt baths attack oxide films preferentially. Most of the metal loss that results from acid pickling is eliminated.
- Since attack is virtually eliminated on metals inherently resistant to caustic soda, different types of metals and alloys can be descaled simultaneously. This is particularly true in the sodium-hydride bath.
- Life of the bath is comparatively high. Normally, the only additives required are those needed to compensate for drag-out losses. To some extent, salt baths are regenerative.

Although the procedures involved in salt-bath

descaling differ to some extent with each type, all have the same general limitations:

- Since all baths involve caustic soda as a base, materials that may be descaled are limited to those that resist caustic attack.
- Because these baths operate at an elevated temperature, materials that may be descaled are limited to those that will not undergo undesirable property changes.
- For economical operation, a salt-descaling bath should be operated continuously.
- Parts must be dry before immersion. Often a preheat cycle is necessary to remove of all traces of moisture.
- Extremely intricate parts can entrap salt in inside passages.

► Refractory Metals

Conventional pickling acids are generally unsatisfactory for descaling titanium parts because of the tendency of the material to absorb hydrogen. Also, the acids attack the metal. These problems generally have been overcome by using a modified salt-bath formulation. The modification usually consists of small amounts of sodium hydride and titanium dioxide. Results on titanium alloys, after 5 min immersions at 610-645 F, are shown in Table 6⁴.

For removal of heavy oxide coatings on molybdenum, good results have been obtained with conventional molten sodium-hydroxide and sodium-hydride baths. The use of a neutral salt bath at 700 to 975 F for commercial descaling of molybdenum, tungsten, and their alloys has also been successful.

In descaling sheet and fabricated parts of molyb-

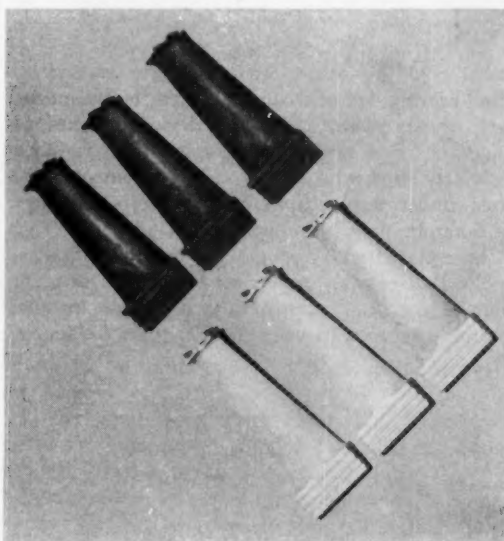
removes all scale and oxide from the molybdenum surface. However, in many instances, a subsequent dip in alkaline permanganate and 10 per cent sulfuric acid has been found necessary to remove a light tan stain that sometimes appears. This stain becomes more pronounced when a prolonged cooling cycle is used between the descaling salt bath and a water quench or rinse.

Effective descaling of tungsten, molybdenum-tungsten, molybdenum-zirconium, and molybdenum-zirconium-titanium alloys can be obtained by proper selection of immersion time and bath temperature. Metal oxides and other insolubles settle out of the descaling bath in the form of a sludge.

After being vapor degreased to remove gross soil, fabricated tungsten parts may be cleaned by a variety of procedures. Some successful methods are: 1. Sodium-hydroxide bath. 2. Sodium hydride bath at about 1100 F. 3. Electrolyzing for 30 sec in a 20 per cent potassium-hydroxide solution. 4. Boiling for 20 min in a 20 per cent potassium-hydroxide solution. To remove last traces of oxides, heating the part in a hydrogen atmosphere at about 1800 F is recommended.

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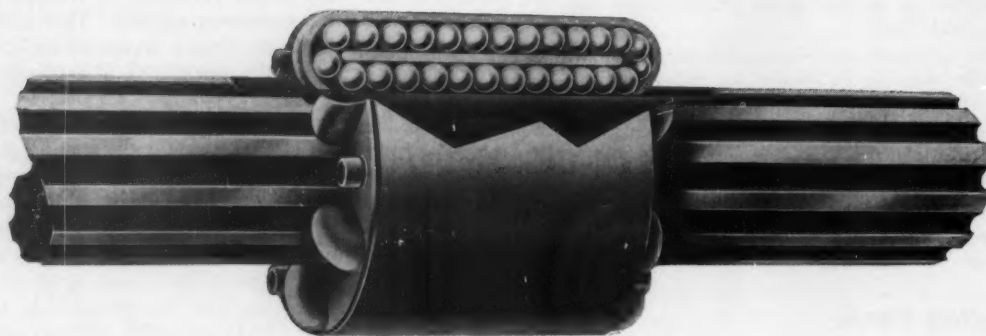
Scale and oxides are removed from gas-turbine blades by a salt-bath treatment used during engine-overhaul procedure. Cycle consists of: Kolene No. 1 bath, 12 min at 900 F; water quench and rinse; inhibited muriatic-acid bath; water rinse and dry.

denum and its alloys, immersion time in the salt descaling bath varies with bath temperature and surface condition of the metal. The salt essentially

They Say . . .

"The whole relationship between science and technology has changed. As the store of scientific knowledge has increased and the techniques of science become more powerful, it has become possible and even advantageous to apply the methods of knowledge of one science to the problems of another. It is now possible for science to handle many complicated practical problems. Likewise, technology has become so intricate that empirical methods have become inadequate. It has become both necessary and possible to apply science to engineering."—O. S. CARLISS, Director of Engineering, Materials Handling Div., Yale and Towne Mfg. Co., Philadelphia, Pa.

"In engineering communications the problem arises in the time and effort required for communicating rather than creating. The chief means of communication—engineering drawings—are complicated and time consuming. With the passage of time, more and more information has been added to them which is of local usefulness only, and tends to obscure their primary purpose. Any change in an engineering drawing requires the change be recorded in many places, and it must be communicated far and wide before it reaches all interested persons."—NORMAN J. REAM, director of systems planning, Lockheed Aircraft Corp., Burbank, Calif.



Matching

Ball-Bearing Splines

to torque, radial-load, and life requirements

DAN R. ROWLAND

Project Engineer
Saginaw Steering Gear Div.
General Motors Corp.
Saginaw, Mich.

BALL-BEARING splines offer several advantages over conventional splines: 1. Efficient linear movement under high torque conditions. 2. Average coefficient of friction of only 0.005—approximately one-fortieth that of conventional splines. 3. Substantial weight reduction. 4. Longer life.

Ball-bearing splines are not splines in the accepted sense. Rather, they consist essentially of an inner race and an outer race, separated by load-carrying balls which are recirculated through closed circuits. Grooves forming the ball paths on both the inner and outer races are of "gothic-arch" cross-section, Fig. 1. This configuration minimizes lash by reducing the radial and angular freedom of the assembly. It also provides clearance space for small foreign particles that might enter the spline.

Standard inner races are available in lengths from 6 to 144 in., in 6-in. increments. Inner races generally have twelve axial ball grooves, which are cold rolled along the periphery of a centerless-ground bar. The outer races have six ball grooves and three return holes. Only three of the outer-race ball grooves are generally used. If three additional return holes are drilled, all six grooves can be used to provide increased load-carrying capacity. Stamped end caps are fastened to the end faces of the outer races to direct the balls to the return holes.

Ball-bearing splines can be fitted with integral gears or sprockets, clutching devices, trunnions, flanges, bearings, or other attachments. These splines are widely used where free linear movement is required under torque from cantilever-type loadings. For example, parallel support shafts and guide rods can be replaced with a single ball-bearing spline assembly. Ball-bearing splines are being used as guide members for the reciprocating heads of internal grinding machines, in work-transfer units for stamp-

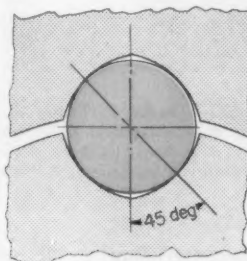


Fig. 1—Cross section of grooves in ball-bearing spline. Gothic-arch configuration reduces backlash by limiting radial and angular movement.

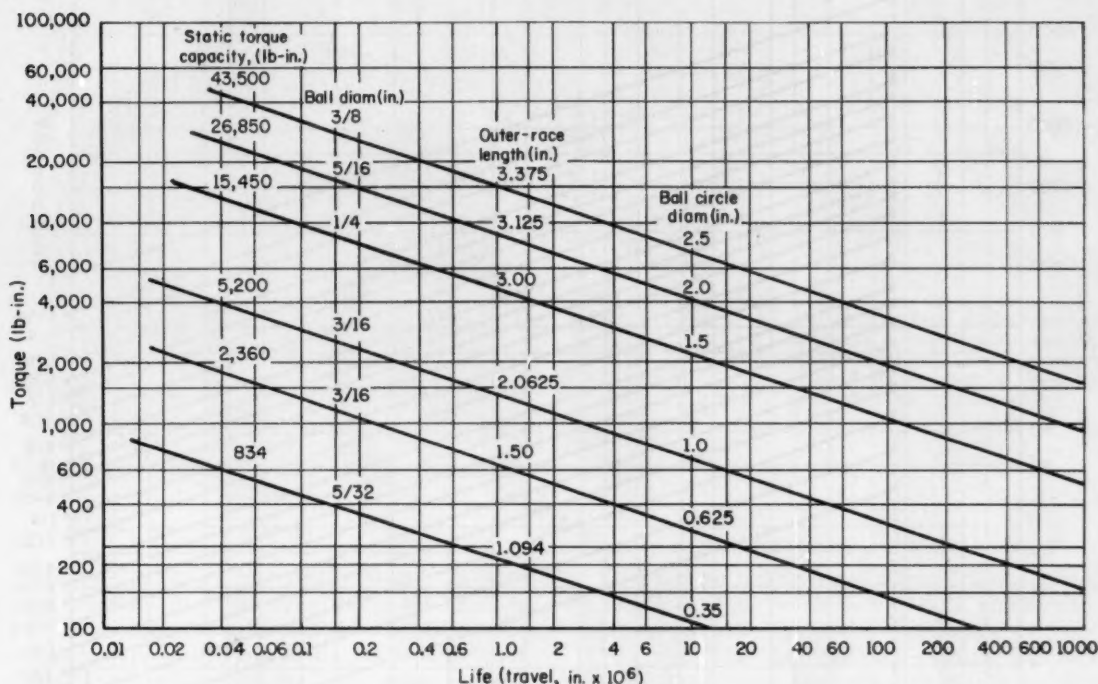


Fig. 2—Graph for selecting standard ball-bearing splines to meet life and torque requirements. Upper five diagonal lines represent standard splines of Rc 60 with cold-rolled inner-race ball paths and broached outer races. Lower line represents standard spline with ground paths.

ing presses, and in remote-controlled "mechanical-arm" manipulators.

► Selecting Standard Splines

Each ball-bearing spline assembly is designed to carry a specific torque or radial load for a given amount of travel. The maximum allowable torque or load depends on: 1. Hardness of the balls and raceways. 2. Number and size of active torque-carrying balls in the assembly (determined by the active length of the outer race). 3. Fatigue properties of the material.

Load ratings have been determined by comprehensive testing under simulated service conditions, and are usually specified in inches of travel.

For pure-torque applications, standard ball-bearing splines can be selected for a given life requirement and torque loading from Fig. 2.

The diagonal lines, which are based on test data, represent standard ball-bearing spline dimensions for given torque-life relationships. These lines terminate at torque values which are considered to be the maximum static, non-Brinell condition for the raceways.

When the lines for torque and life do not intersect one of the lines for a standard spline, the next largest spline should be used.

If running torque is to be exceeded, maximum torque should be checked against static capacity. Also, environmental conditions may affect selection. For example, it may be necessary to specify corrosion-resistant or heat-resistant materials for the splines.

The spline must be large enough to withstand maximum beam-load conditions without buckling. Also, spline rotation must not exceed any critical speed in those applications when critical speed is a factor.

EXAMPLE: Assume that desired life = 50,000,000 in. of travel; torque to be transmitted = 2500 lb.-in.

Locate the intersection of life value and torque value. The nearest diagonal line above this point indicates a standard spline with 5/16-in. balls, a 3.125-in. outer race, and a 2-in. ball-circle diameter.

► Designing Nonstandard Splines

A standard spline may not be available to meet certain application requirements. In this case, a non-standard spline can be designed to fit the conditions. Designing a nonstandard spline for a given life is not difficult, once the load conditions have been determined.

Torque: The torque capacity of a ball-bearing spline for a specified life can be determined from the

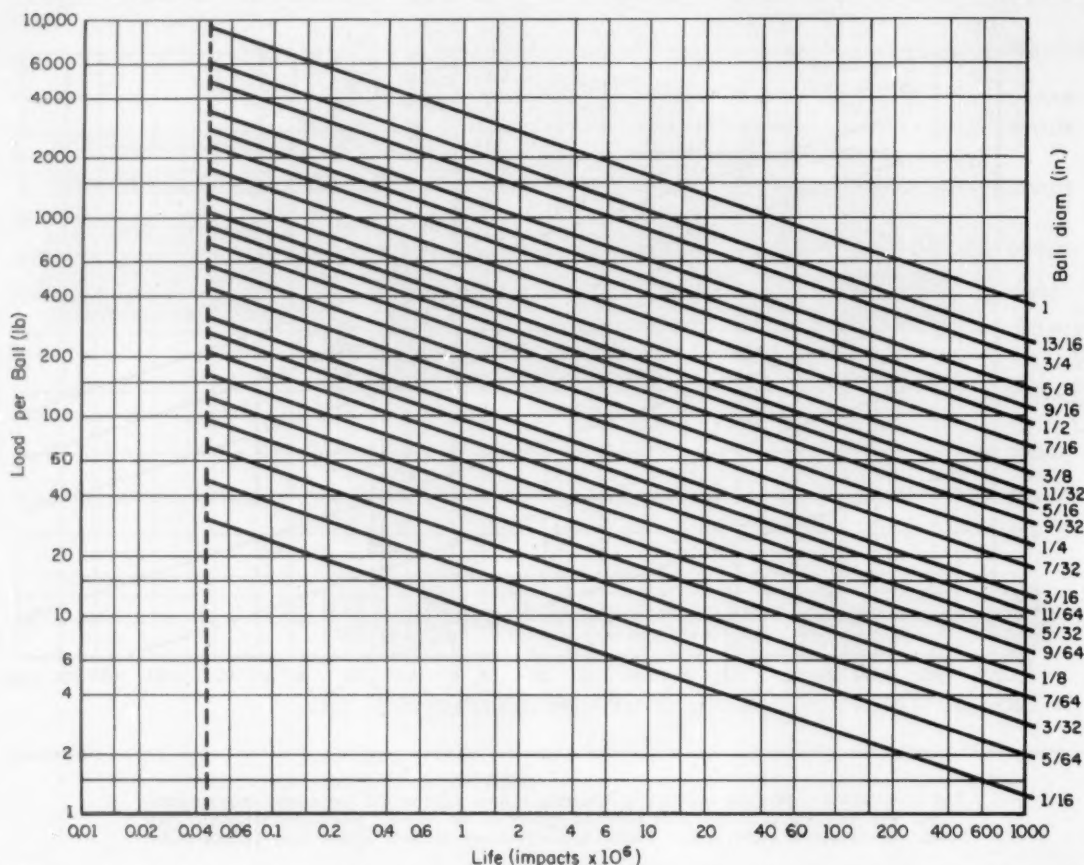


Fig. 3—Load-carrying capacities of various diameter balls for given life requirements in impacts. Limiting mean Hertz stress, dotted line, is 550,000 lb.

number of impacts it undergoes. By definition, an impact is the linear travel equal to one ball diameter:

$$I = \frac{1}{2d} \quad (1)$$

where I = number of impacts per in. of travel of the outer race; d = ball diameter, in.

EXAMPLE: Assume that a life of 1,000,000 in. of travel is required. Ball-circle diameter = 4 in. There are three ball grooves, each containing 15 active balls, $\frac{3}{8}$ -in. diam. Then, from Equation 1

$$\begin{aligned} I &= \frac{1}{(2)(3/8)} \\ &= 1 \frac{1}{3} \end{aligned}$$

Thus, required life $(1 \frac{1}{3})(1,000,000) = 1,333,333$ impacts. From Fig. 3, for this impact life, the spline has a load-carrying capacity of 440 lb per $\frac{3}{8}$ -in. ball. Torque capacity is then determined by multiplying load-carrying capacity per ball (440 lb) by number of balls (15), number of ball grooves (3), and radius (2 in.). Thus, torque capacity = 39,600 lb-in. for a life of 1,000,000 in. of travel.

Radial Loading: If splines are to be subjected to pure radial loading, each application must be considered individually. The impact-life graph, Fig. 3, is based on life tests of ball-bearing screws. The loads shown are axial loads on the balls produced by the axial nut loadings on the ball-bearing screws. With the 45-deg. contact angles of the gothic-arch ball grooves, the actual normal ball loadings are 1.414 times the axial ball loadings. For radially-loaded ball-bearing splines, it is necessary, therefore, to determine the equivalent ball loadings before finding the expected life from the graph.

A diagrammatic representation of a ball-bearing spline inner race, having three ball grooves, is shown in Fig. 4. For a given load P on ball 1, there is a load vector P_o on each of the two contact areas. Load vectors P_o are equivalent to the single load vector upon which Fig. 3 is based. However, ball 2 and ball 3 each carry a much smaller load. Addition of the load-carrying vectors shown in Fig. 4, for various positions of the balls, shows that in the most adverse positions, the load-carrying capacity is about 2.6 times that used in plotting Fig. 3.

To determine the life of a radially-loaded ball-

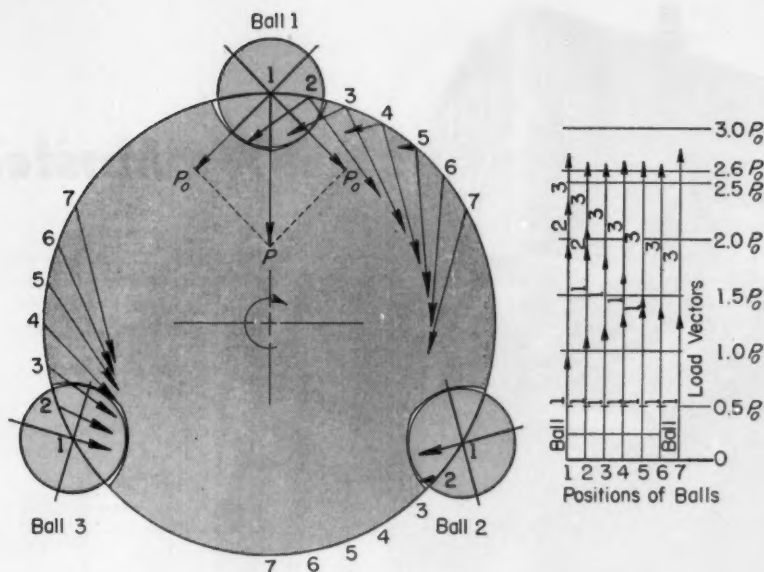


Fig. 4—Graphical analysis of ball loads in three-groove ball-bearing spline under radial load. Numbers around the periphery of the inner race represent ball positions.

bearing spline having three ball grooves, it is necessary, therefore, to divide the applied radial load by 2.6. Thus, when this value is divided by the number of active balls in one groove, the result is the equivalent load-carrying capacity for a given ball size. Then, Fig. 3 can be used to determine the life in impacts. To calculate the life in in. of travel, the equivalent load-carrying capacity is divided by $1/2d$, which is the number of impacts per in. of travel.

To determine the life of radially-loaded ball splines having four, five, or six ball grooves, similar calculations are used. Under the most adverse positions of the balls, the load-carrying capacity for four grooves is 2.8 times the values in Fig. 4; for five grooves, 4.4 times; for six, 5.3 times. Thus, slightly higher load-carrying capacities can be obtained by selective positioning of the inner race.

Tips and Techniques

Smoothing Tabulated Data

Sometimes, particularly in tabulated experimental data, it is desirable to revise the figures to smooth out slight irregularities. The following equations, based on the least-squares method, will fit the values to a second-degree parabola. The method requires only that the independent variables be evenly spaced. The y -values are the original points; the y' -values, the smoothed points.

$$y'_0 = \frac{1}{70} (69y_0 + 4y_1 - 6y_2 + 4y_3 - y_4)$$

$$y'_1 = \frac{1}{35} (2y_0 + 27y_1 + 12y_2 - 8y_3 + 2y_4)$$

$$y'_2 = \frac{1}{35} (-3y_0 + 12y_1 + 17y_2 + 12y_3 - 3y_4)$$

$$y'_3 = \frac{1}{35} (2y_0 - 8y_1 + 12y_2 + 27y_3 + 2y_4)$$

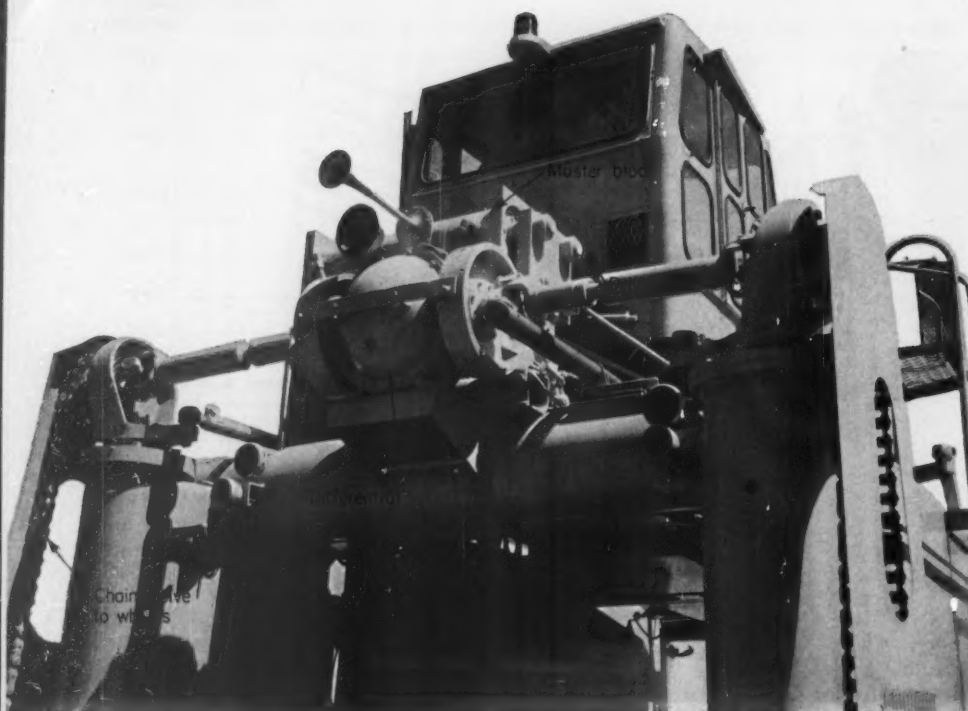
$$y'_4 = \frac{1}{70} (-y_0 + 4y_1 - 6y_2 + 4y_3 + 69y_4)$$

The first and second equations are used to smooth out the first two points in the tabulation. The third equation is used for all the remaining points except the last two, which use the fourth and fifth equations. Each successive step uses the smoothed values already calculated. This method is particularly useful when it is necessary to draw a curve through a number of points that may vary from a smooth curve.—NORMAN M. WICKSTRAND, *Harwin-ton, Conn.*

Rectangular Pressure Vessels

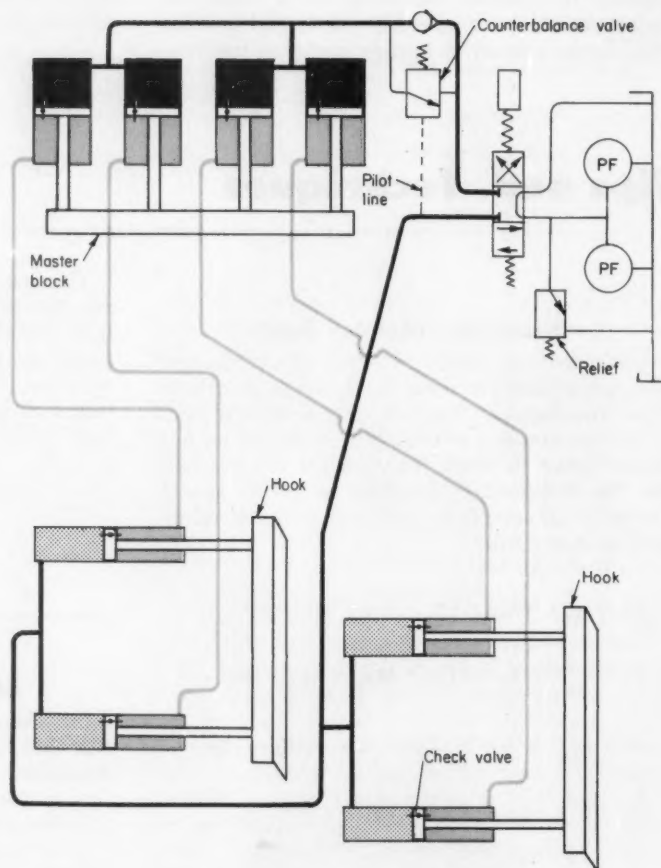
In "Designing Rectangular Pressure Vessels," p. 152, May 25, 1961, the first equation for y , Table 1, should be:

$$y = \frac{(wt) \frac{t}{2} - (Bh) \frac{h}{2}}{wt + Bh}$$



Master

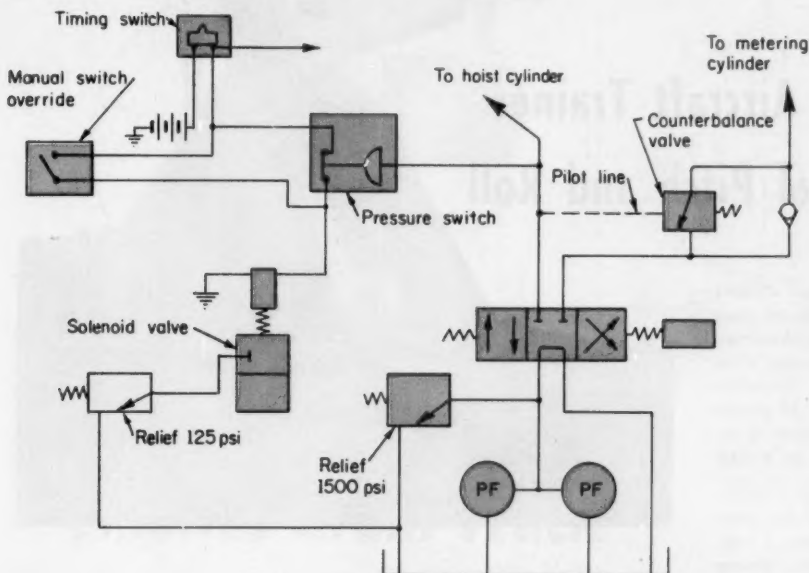
MASTER BLOCK consists of a group of four metering cylinders in a rectangular cluster, with the four piston rods mechanically fastened to move together. Each cylinder has a slave cylinder below lifting one corner of the load.



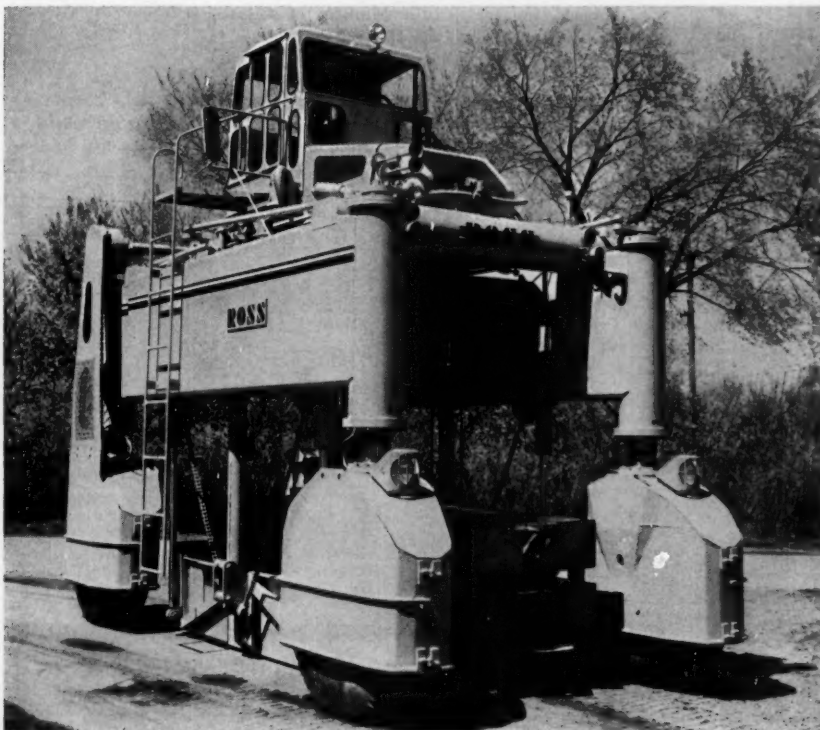
Counterbalance valve blocks lowering of load until triggered by pilot line. This assures positive control of the load at all times. And provides a controlled lowering speed proportional to pump speed.

Cylinders Keep Slaves in Line

HIGH-LIFT straddle carrier uses a master-slave cylinder combination to lift eccentric loads. Heavy loads could be dangerous to lift hydraulically without the proper controls: In a poorly designed machine, the cylinder carrying the lightest load might run away from the others, causing severe stresses and possibly dumping the entire load.



Long piston rods which might buckle are protected by a pressure limiting safety system built into the lowering side of the hydraulic circuit. Pressure switch normally limits pressure in the lowering line to 125 psi. A manual override permits the hoist to be used as a jack for tire changes.



High lift straddle carrier with 60,000-lb capacity and 48-in. lift height was developed by the Industrial Truck Division, Clark Equipment Co., Battle Creek, Michigan.

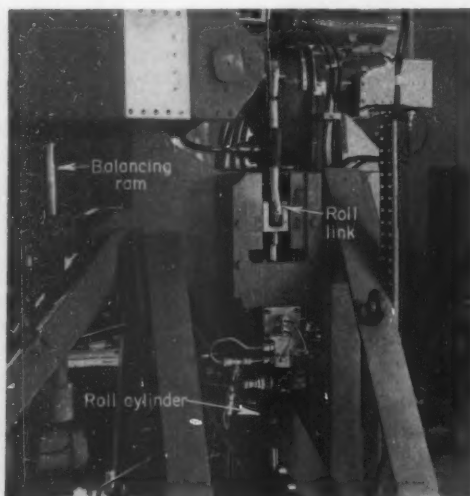
Rocking-Horse Aircraft Trainer Gives Pilot Real Pitch and Roll

COCKPIT mounted on a boom makes motions more nearly like those of a real aircraft than conventional bolted-down trainer. Acceleration of pitch and roll check the pilot's reactions to real flying situations. Electrohydraulic servo units tilt the cockpit 15 degrees to either side in 1/3 sec and move it up or down through a 30-degree arc in a little over 1 sec.

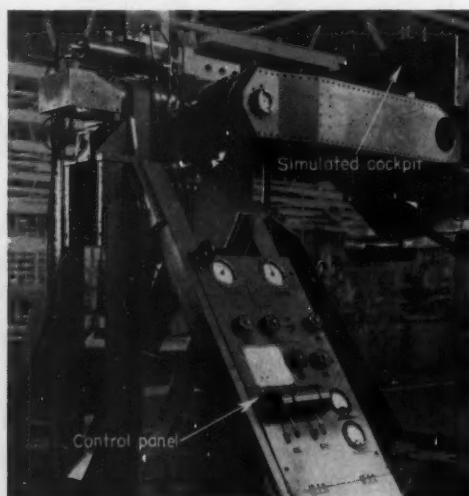
In simulated still air the pilot has complete control over these movements; a computer programs into the servo system adverse conditions a pilot might face flying through cross winds, gusts, or turbulence.

Estimated overhang moment of pilot and cockpit at the end of the 6-ft boom is 4200

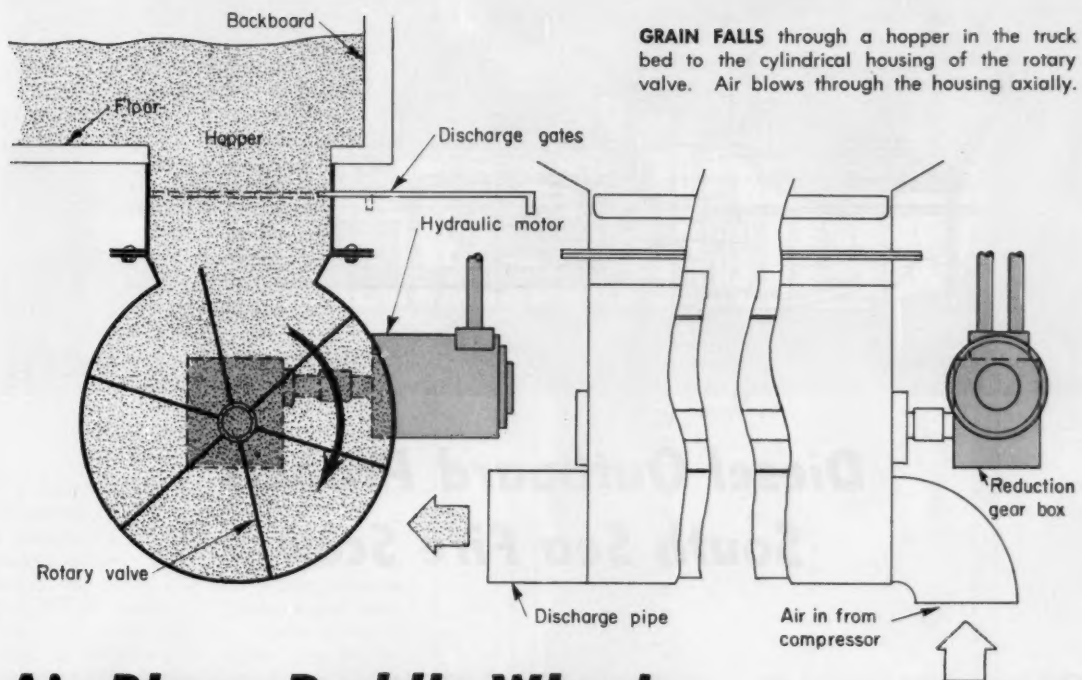
lb-ft. A balancing ram keeps the strain of this moment from the servomotor. Trainer was designed for the British Ministry of Aviation by Short Brothers & Harland Ltd., Belfast, Ireland.



COCKPIT ARM RIDES on a hydraulic piston. Roll link compensates for pitch as it transmits roll motion from actuator to simulator arm.



UNEXPECTED FLYING CONDITIONS are programmed from the control panel. Hydraulic lines are controlled from the same panel.

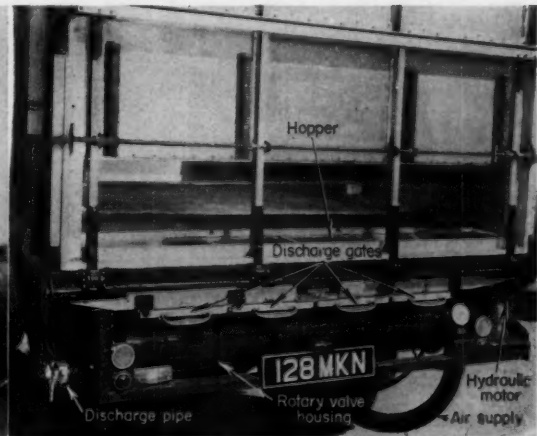


Air-Blown Paddle Wheel Empties Grain Truck

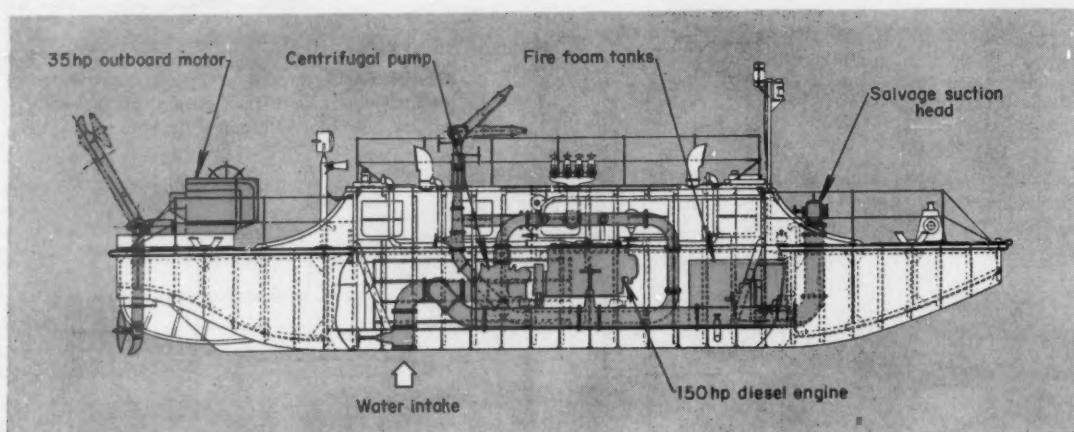
ROTARY VALVE that unloads a bulk-loaded grain truck resembles the paddle wheel on a stern wheeler. Paddles keep grain from packing in the path of an air stream that whisks it into the receiving warehouse or bin. The assembly is driven by a hydraulic motor. Air compressor and motor are part of truck-mounted system.



FLEXIBLE HOSE connects rotary-valve discharge pipe to the receiving bin.



TRUCK BED tilts like a dump truck's to pour grain into the discharge hoppers. Self-discharging truck was developed by Bonallack & Sons Ltd., Essex, England.



Diesel Outboard Propels South Sea Fire Scow

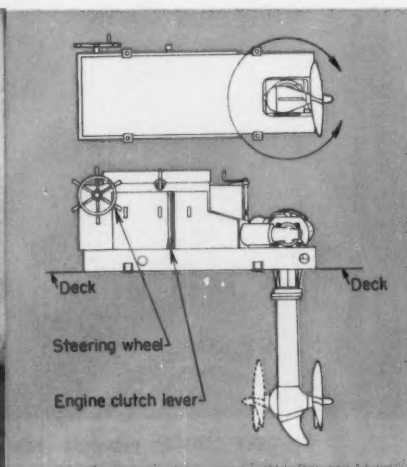
OUT from underfoot of hustling firemen in the engine room, a fireboat's propulsion unit and its operator are moved to the stern deck. Propeller doubles as rudder since it can be rotated 360 degrees about its vertical axis. It rocks up on the stern to ride over sunken snags. It can be hoisted out of the water for servicing without detachment from the engine.

In contrast to the modest 35-hp propulsion engine, the diesel pump powerplant is a husky 150-hp unit capable of drawing 1800 gpm through the salvage hose, or throwing a fire-fighting stream at rates up to 1200 gpm.



Scow-shaped hull was designed by Courtney, Hughes and Partners, Ltd., Twickenham, England, and built by Merryweather and Sons Ltd., Green-

wich, England. The first fire fighter, called Dau Tataro, was sent to the Fiji Islands. A second one is on the way to Baghdad.

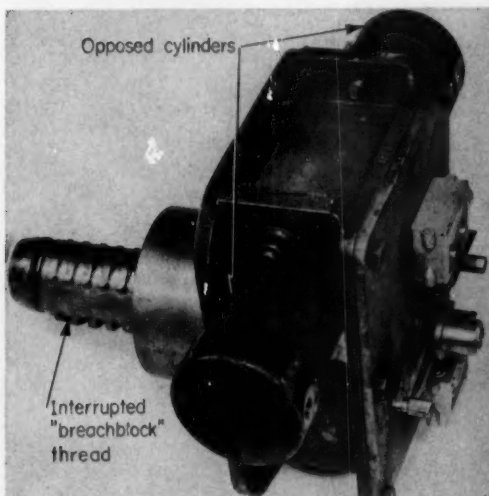
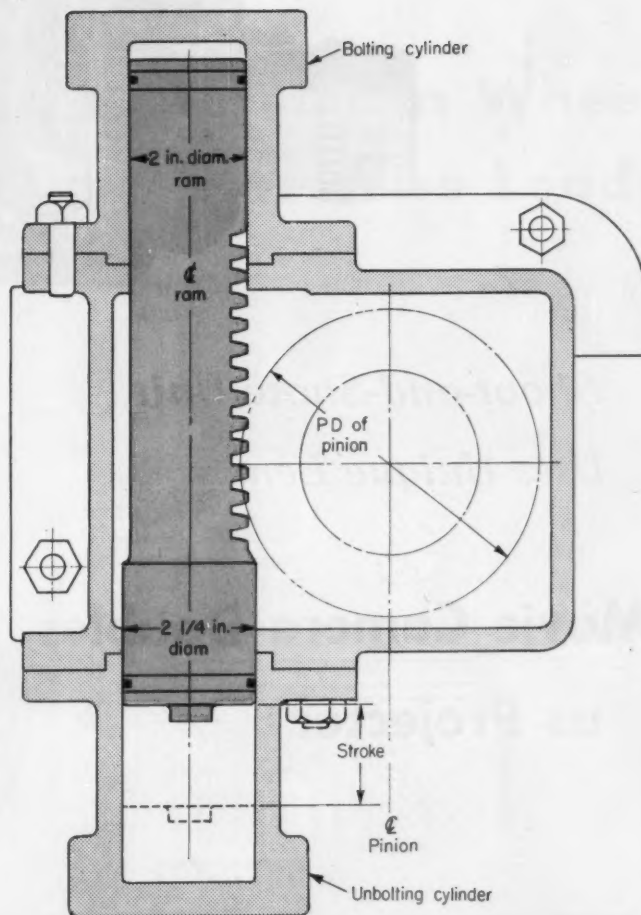


RIGHT-ANGLE gearing operates propeller with stem rotated in any position around two axes.

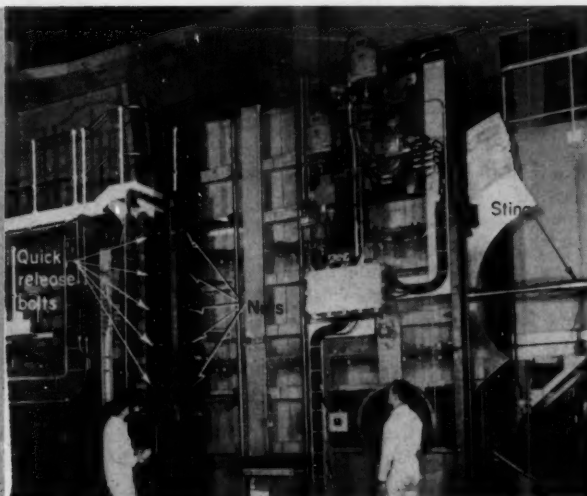
Breech Bolts Speed up Wind-Tunnel Model Changes

INTERRUPTED threads, like those on the breechblock of a bolt-action rifle, gives bolts on a wind-tunnel section positive action with a fraction of turn. A double-ended hydraulic actuator, incorporating a rack section, operates each bolt by means of a pinion-shaped head. Piston diameter in unbolting cylinder is slightly larger to compensate for higher static friction in the securely fastened bolt.

To mate properly with the nut, the bolt must always be in the same position when unlocked. This is assured by assembling the unit with the ram hard against the lock cylinder head and the bolt in the required unlock position. Nuts are installed in the mating flange with 1/16-in. rotational freedom to allow for slight misalignments. Quick-release bolts are used in a Mach-4 wind tunnel recently opened by the RAF in Bedford, England.



INTERRUPTED THREADS lock with less than half a turn of the bolt. Similar internal threads in the nut mesh with the bolt in open position.

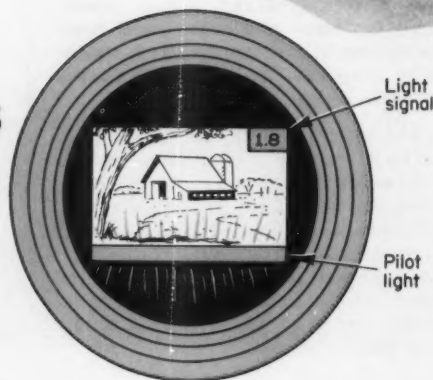


BOLTS RELEASE quickly when the tunnel section is moved for model changes. Bolt is actuated by a valve in easy reach of operator.



Shoot-and-Show Unit Uses Unique Lens

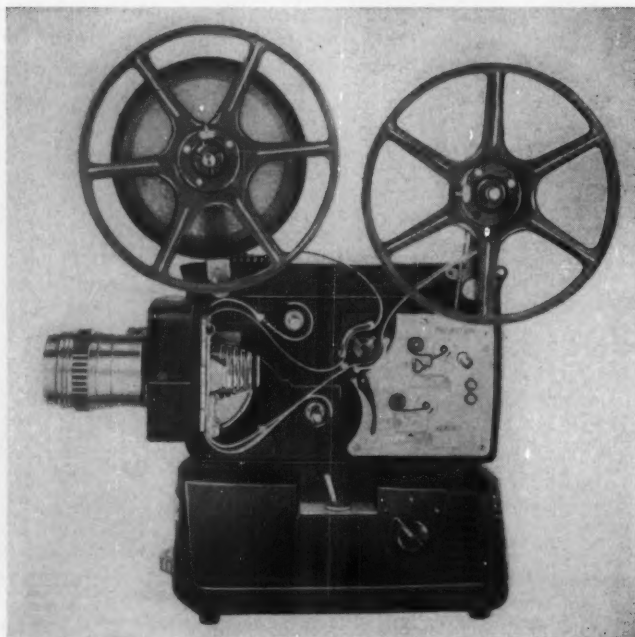
Movie Camera Doubles as Projector

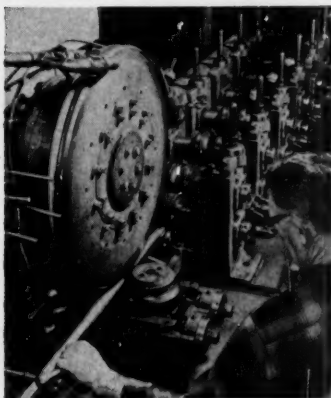


COMBINATION camera—projector uses a lens that combines the resolution of a taking lens with the high contrast of a projection lens. Problem was solved by use of a new rare-earth glass, elimination of bevels in lens elements, and careful design of air space and curvature of lens elements.

A zoom mechanism in the new lens gives an added bonus by matching projected image to screen size without movement of the projector.

Light signal in the corner of the viewfinder warns the photographer when light is insufficient for good pictures. Pilot light at the bottom of the finder goes out when battery power gets low. The new camera is the latest model of the Cine-Twin produced by Longines-Wittnauer Watch Co., Inc., New York City.



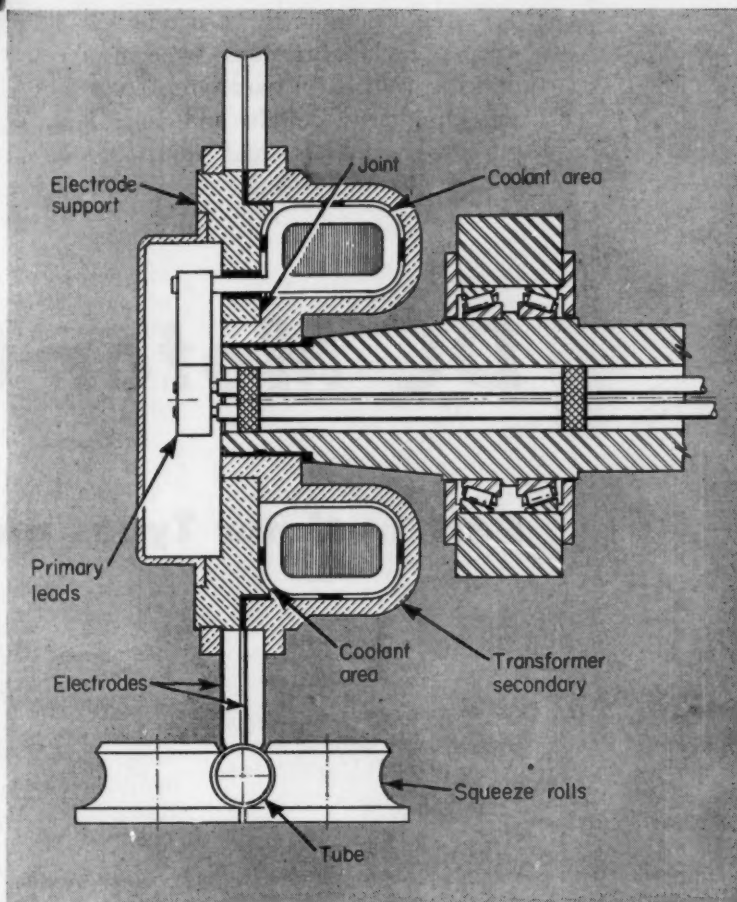


Transformer in Wheel Eliminates Wire Leads

Centering transformer mass within the welding wheel produces three distinct advantages for a new welder:

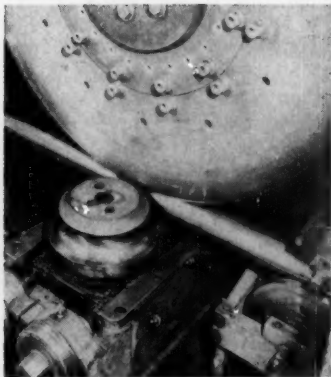
- It eliminates one set of bearings.
- Bending stresses are not transmitted through transformer body.
- Leads from secondary to electrode are eliminated.

Factors making possible the more compact design are use of a dielectric coolant (principally isomers of perfluorocycloether) that has a heat-transfer capability ten times that of conventional transformer oil, and new thin electric insulating materials that provide dielectric strength without bulk and heat insulation. Laminated transformer core was made by wrapping up a continuous strip of grain-oriented silicon steel. Absence of joints makes a continuous magnetic path for high efficiency. The Type-V resistance welder was developed by The Yoder Co., Cleveland.



TOROIDAL TRANSFORMER situated within the encircling electrodes rides on a single set of bearings. It supports little or no bending moment.

STEEL TUBING is produced by the new unit. Six sets of rolls (not shown) turn flat stock into a tube. The final rolls (under the electrodes) close the seam while the electrodes weld it.



Gaining the virtues inherent in dc motor drives depends upon selection of the right controls. And choosing these control devices depends upon the basic type of dc motor used in a given application. Accordingly, this first article of a series deals with the three basic types of dc motors, their general electrical construction, and their operating characteristics.

Future articles in this program will discuss circuit functions of control devices, controller hardware, accessory equipment, definite and general-purpose controllers, and adjustable-voltage control systems.

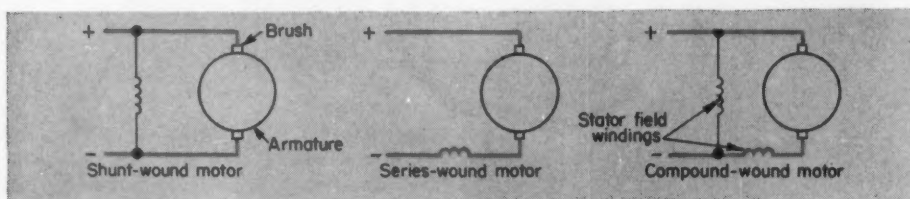
DC Motor Control

Part 1—Motor Types and Characteristics

*... motor fundamentals
which influence proper
selection of control devices*

J. RONALD WICKEY

Staff Engineer
The Clark Controller Co.
Cleveland, Ohio



REQUIREMENTS for a wide variety of industrial drives often can be met only by dc motors. Their performance and ease of control are basic necessities for many processing lines and other similarly complex systems. Applications for which dc motor types are most suitable may require one or more of the following features:

1. Wide speed range.
2. Small incremental speed changes.
3. Speed matching.
4. Smoothness, or a specific rate, of acceleration or deceleration.
5. Limited or controlled torque or tension.

Dc motors can be used where basic ac drives are often unacceptable. Ac motors are inherently constant-speed machines. Although multispeed and adjustable-speed operation are possible, complex motor design and associated control equipment are required. By comparison, dc motors are inherently adjustable-speed machines, and only a minimum of design considerations and additional control equipment are necessary to take advantage of this important feature.

With respect to application characteristics, dc motors are classified according to the type of field winding. There are three types—shunt wound, series wound, and compound wound. Operating characteristics of these three motor types are quite different from each other and are described here. However, regardless of the windings, certain mathematical relationships, Table 1, remain the same.

● Shunt Motors

In a shunt-wound motor the stator is energized by line voltage or some other source of constant po-

Table 1—Dc Motor Equations

$$\text{Torque} \\ T = K_1 \phi I_a \quad (1)$$

$$\text{Speed} \\ S = \frac{E - I_a R_a}{K_2 \phi} \approx \frac{E}{K_2 \phi} \quad (2)$$

$$\text{Power} \\ P = \frac{TS}{5252} \quad (3)$$

Nomenclature

- E = Supply voltage, v
 I_a = Armature current, amp
 K_1, K_2 = Motor constants
 P = Output power, hp
 R_a = Armature-circuit resistance, ohms
 S = Speed, rpm
 T = Torque, lb-ft
 ϕ = Field flux, lines per sq in.

tential. Field excitation is thus independent of the current flowing through the armature of the machine. With this arrangement the field is essentially connected in parallel with, or in shunt with, the armature circuit. Hence, the expression, "shunt" motor, is descriptive of the field connections.

In modern motor design many shunt motors contain a low-effect series-type winding called the commutating field. This winding, which may have only one or two turns, is connected in series with the armature circuit. These turns of large-size wire, placed on interpoles located between the main field poles of the magnetic structure, improve the commutating characteristics of the motor.

In addition, many modern shunt motors also contain another low-effect series winding usually called a stabilizing winding. This winding, which again is likely to have only one or two turns, is placed on the main field poles with the shunt winding. Its

principal purpose is to help stabilize the running characteristics of the motor.

Both of these auxiliary windings—commutating and stabilizing—have such a small effect on the application characteristics of a shunt motor that their presence can usually be ignored in control design.

The shunt-field winding is designed to keep field current at a relatively low value, usually less than 5 per cent of the armature full-load current. Consequently, to ensure sufficient field strength, the field is wound with a large number of turns of small wire. As a result, the shunt winding is highly inductive. This factor must be considered when motor-control equipment is applied to the shunt circuit.

If the field circuit is interrupted or suddenly reduced, an inductive "kick" or reaction will tend to cause arcing at the contacts of any device which produces the current change. Therefore, blowouts or other arc-quenching means must ordinarily be incorporated on such devices. In addition, the voltage induced by an interrupted field circuit may rise to such a value that the insulation for the shunt field is punctured or damaged. To limit this voltage to a safe value, the control system must usually

provide a discharge path to absorb the energy stored in the inductive field circuit.

Because field current (and field flux) is independent of armature current, the shunt motor is well suited for general use. Varying the strength of the shunt field produces a variation in the speed of the motor. To maintain good running stability and a reasonable amount of running torque, the speed range of the shunt motor is usually limited to about 4 to 1. The shunt motor also tends to maintain its running speed even though load requirements increase or decrease considerably.

The most important limitation of the shunt motor is its moderate starting torque. Therefore, it is not too suitable for high-inertia load applications. General operating characteristics of shunt-wound motors are shown in Fig. 1.

• Series Motors

As its name implies, a series motor produces its field flux by a winding which is in series with the armature circuit. Therefore, to provide the necessary magnetic strength, the field winding need consist of a comparatively few turns of wire or conductor. The wire, however, must be capable of carry-

Fig. 1—Typical characteristic curves for shunt motors. Curve *a* is current-torque curve; curve *b* is speed-load curve.

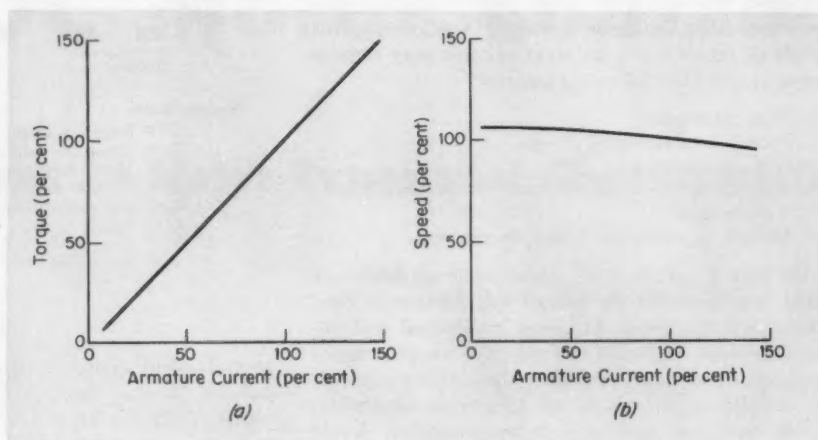
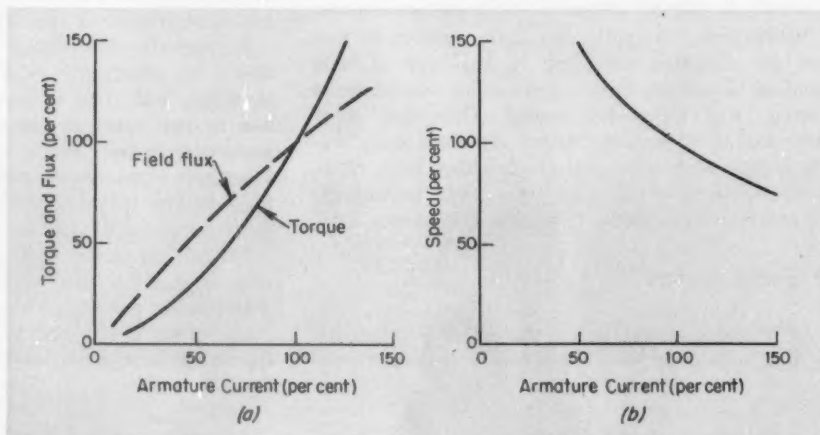


Fig. 2—Typical characteristic curves for series motors. Curves in *a* are current-torque curve and, for reference, a curve of load current versus field strength. Curve *b* is speed-load curve.



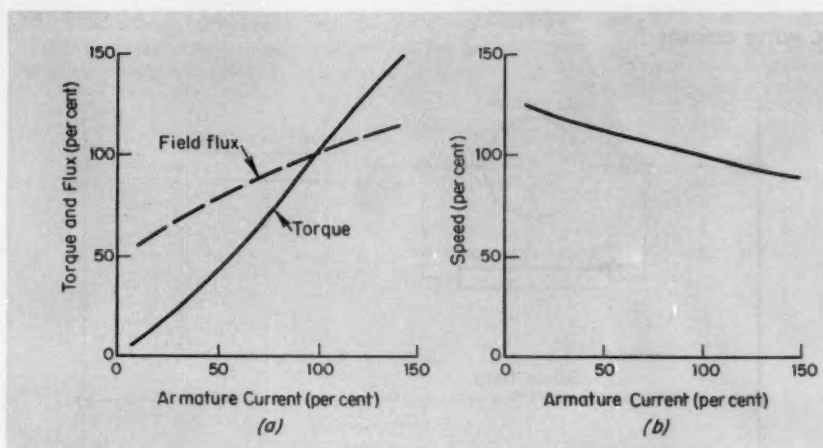


Fig. 3—Typical characteristic curves for compound motors. Shown in *a* are current-torque and field-strength curves; in *b* is speed-load curve.

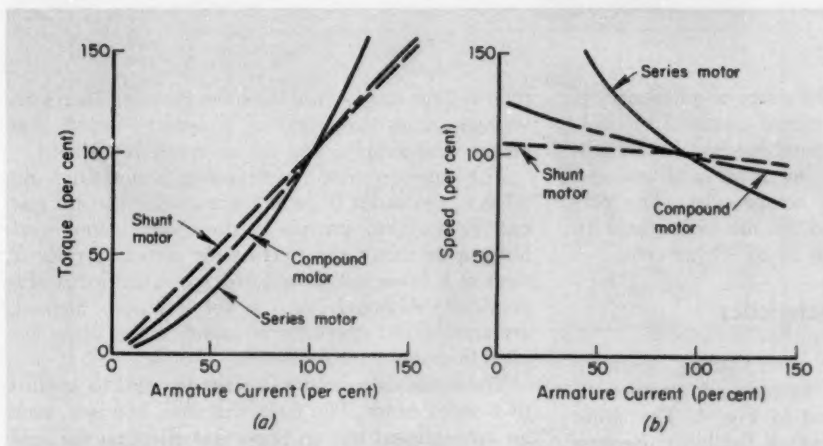


Fig. 4—Superimposed current-torque curves, *a*, and speed-load curves, *b*, for comparison of typical characteristics of shunt, series, and compound-wound motors.

ing the armature current (load current) without overheating. For large motors, the series field is usually wound with square or rectangular conductors. Such construction results in a rugged mechanical assembly.

Since a change in armature current also means a change in field flux, both torque and speed are highly affected by the load current. If the field poles did not become saturated, torque would vary as the square of the armature current. However, saturation is always present to some degree, and resultant torque ranges somewhere between the first and second power of the current. The exact value can be determined only by calculation from basic motor design information. Usual practice is to work from typical curves, such as Fig. 2, when the need arises.

At light load, speed of a series motor can easily become excessive. At very light load the motor might possibly reach a dangerous runaway speed. Therefore, a series motor must not be used for any application where the connected load can become very small or be lost entirely.

Another limitation to series-motor application is that speed cannot be adjusted by practical means. Fig. 2*b* indicates how widely speed varies with a change in armature current or load. Consequently, a series motor offers little or no flexibility in con-

trolling speed.

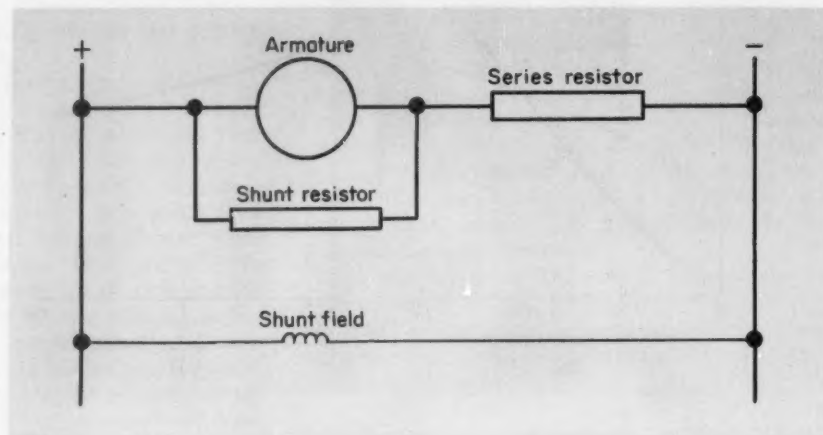
However, one important and useful characteristic of the series motor is its torque response, Fig. 2*a*. Drives for equipment which requires high starting torque, such as cranes, are ideal applications for series motors.

• Compound Motors

The features of shunt and series motors are combined in a compound-wound motor. Both a shunt winding and a series-type winding are used to supply field flux. However, the proportion of total flux supplied by each of the windings is not a fixed value, and there is no standard value for this proportion. Depending upon the expected use of the motor, and possibly upon the motor manufacturer, the series field at full load usually produces 40 to 75 per cent of the total field flux. A ratio of 50 per cent is widely used.

As might be expected, characteristics of a compound motor lie somewhere between those of a shunt motor and a series motor, Fig. 3. Compound motors are most commonly applied where a fairly large starting torque is required but where constant speed with varying load is not necessary. Because a compound motor does have a shunt field, its speed can be adjusted by adjusting the current through

Fig. 5—Circuit for armature-shunt operation of shunt motor. Combined effect of resistors causes motor to operate at reduced speed.



the shunt field. However, the range of adjustment is quite low and would rarely exceed a ratio of $1\frac{1}{2}$ to 1.

Many of the motors in general industrial use might be called special cases of the compound motor—usually described as lightly compounded. The portion of total flux produced in the series field in such motors may vary from 10 to 25 per cent.

● Comparison of Characteristics

For reference, curves of corresponding operating characteristics for shunt, series, and compound-wound motors are combined in Fig. 4. The shunt motor offers the greatest over-all flexibility. Because of the large conductor size used for its stator winding, the series motor is structurally the most simple and rugged of the three basic dc motor types.

● Operation at Reduced Speeds

In some applications a motor must operate at speeds below its rated or base speed. Since lower speeds must be produced by some method external to the motor, reduced-speed operation logically becomes a function of the control system.

If the voltage applied across the armature is less than the normal voltage, the motor will run at lower than normal speed, Equation 2 in Table 1. Adjustable-voltage control is one means for reducing the supply voltage to the entire armature circuit to obtain the desired motor speed. Inherently, this method requires a separate and adjustable source of power, such as a generator, for each motor. Although being highly flexible, such a system requires a considerable amount of rotating equipment. Adjustable-voltage control will be covered in a later article.

Since the source of voltage for the armature of a motor is not important, a method using shunt and series resistors in the armature circuit can provide reduced voltage, Fig. 5. In armature-shunt operation, current flowing through the series resistor is the sum of the currents in the armature and the shunt resistor. This total current results in a comparatively

high voltage drop across the series resistor. Therefore, voltage across the armature is reduced below that of the line supply, and motor speed is reduced.

The armature-shunt arrangement is most often applied to the shunt or lightly compounded motor and can be used to provide a slowdown before stop. Since a dc motor can operate for certain periods of time at a lower speed, reduced speed control is also provided. Although not a very flexible method, armature-shunt operation is useful and is often applied in motor-control systems.

The same, or a similar, system can also be applied to a series motor, Fig. 6. In this case, however, such an arrangement has an important effect on the field flux being produced. The result is difficult to predict and varies greatly with a change in the load on the motor. The principal reason for using an armature shunt on a series motor is to limit overspeed rather than reduce speed.

● Dynamic Braking

If the electrical source of power were removed, a motor would stop as a result of its own friction and the effect of any connected load. Such a stop would not be quick, and could be variable—depending upon the type of load. In many instances, a coast-to-stop is satisfactory.

Another method of stopping a motor drive is friction braking with either magnetic, mechanical, or hydraulic actuating means. Because of wear on the wheel and shoes of the brake, especially if frequent stops are required, friction braking is not always satisfactory.

Dynamic braking is a useful method for retarding a motor. This method uses one of the operational characteristics of a motor and requires equipment that is comparatively simple to provide.

When a motor is running, it is also internally acting as a generator. The voltage so produced has a polarity opposite that of the power supply and, hence, is called the counter-voltage or counter-emf. If the motor is disconnected from the power source,

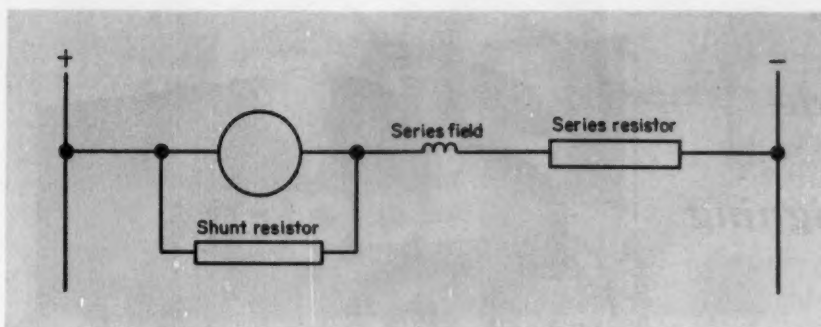


Fig. 6—Circuit for armature-shunt operation of series motor. Depending on the value of each resistor, this arrangement can either provide reduced speed operation or serve to limit overspeed.

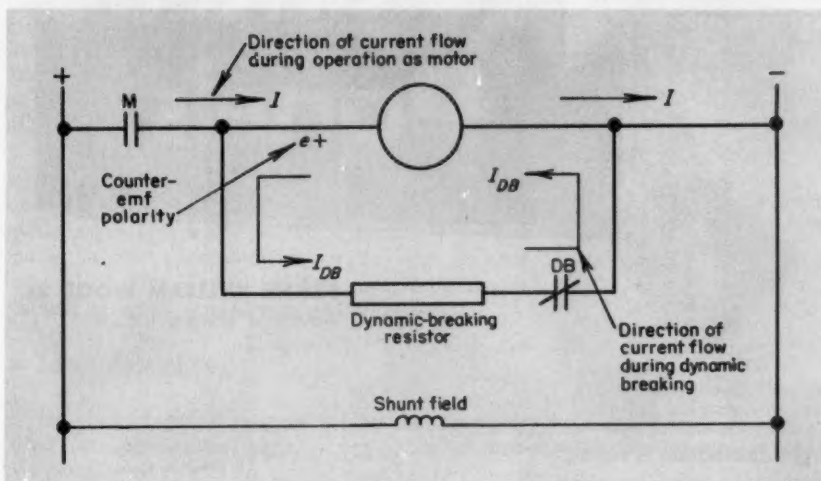


Fig. 7—Circuit for dynamic braking of a dc motor. Contacts M and DB are shown in condition for braking action.

the armature still generates a voltage with the same polarity as before—opposite that of the power supply.

Now, if a resistor is connected across the armature, Fig. 7, the motor acts as a generator, driven by the kinetic energy in the motor and load system, and forces current through the resistor. However, because of the polarity of the generated voltage, current flows through the armature in the opposite direction as compared to the flow during the running by power condition. Torque created by this current opposes the rotation of the armature. Thus, a retarding force is developed, and motor speed is reduced.

As motor speed is reduced, generated voltage, current, and retarding torque are also reduced. Consequently, as the motor slows down, it is acted upon by a steadily diminishing retarding torque. At comparatively low speeds, little braking force remains. When dynamic braking is used, the motor stops as a result of friction rather than electrical retardation.

Additional control equipment can be provided to reduce the value of the dynamic-braking resistor in one or more steps as the motor slows down. Thus, average retarding current and torque are kept at a higher level. This, in turn, provides more effective electrical or dynamic-braking action. Although this method is used occasionally where faster deceleration is required, it is usually not necessary.

Dynamic braking is most conveniently applied to

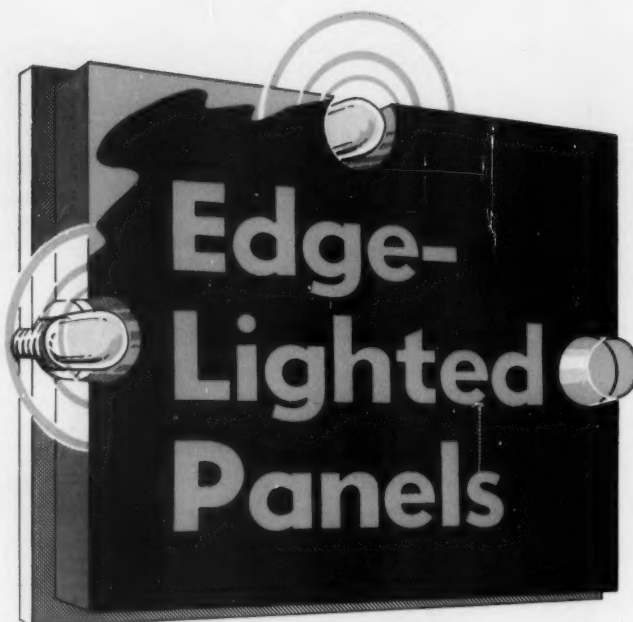
the shunt or lightly compound-wound motor since there is little or no field flux change during the operation. Although it can be applied to the series-wound motor, dynamic braking requires extensive switching; and the results are not too satisfactory because of the continuous reduction of field flux.

Next article in this series will discuss, in building-block fashion, the functional aspects of devices commonly found in a basic dc motor controller.

They Say . . .

"The practical application of basic scientific discoveries is rarely predictable; however, all technology is based on the results of fundamental research and the scientific discoveries which ensue; therefore, if we are going to use the results of fundamental research efficiently, we need men of vision who also have a basic understanding and appreciation of the foundations of this research, and a knowledge of the history of past performance. I believe that our engineering schools provide a far better understanding of this complex process of the assimilation of basic scientific data and its ultimate practical use. This is the knowledge which our coming generation of managers must have."—O. S. CARLISS, Director of Engineering, Materials Handling Div., Yale and Towne Mfg. Co., Philadelphia, Pa.

a
guide
to
designing



FRANK WILLIAM WOOD Jr.

Advanced Designs Inc.
Vienna, Va.

UNIFORM, glare-free light distribution is essential for accurate readability of panel controls and markings. Edge-lighted panel construction provides a reliable solution for this requirement. This article presents a guide to techniques of design and selection of materials for edge-lighted panels and dials.

► Panel Construction

Layout of panels for edge lighting is similar to that for externally lighted panels. Functional requirements are the controlling factors; the lights are considered as additional components to be mounted with special consideration given to the areas to be illuminated.

The preferred thickness for plastic edge-lighted panels is 3/16 in. Military specifications allow deviations of +0.032 and -0.017 in. from this dimension. Such panels are not structurally adequate to support mechanical components and must be backed up by a metal plate. Fastening of panels on a common back-up plate should allow for the differential expansion of the two materials to prevent fracture of the plastic panels, Fig. 1.

Size: Panels should be held to a minimum size compatible with design requirements. An area of 100 sq in. is recommended as a maximum size for a single panel. The plastic material should always be 1/32 to 1/16 in. smaller in width and length than the metal back-up plate to insure assembly clearance with adjacent panels and to minimize

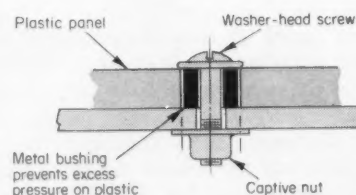
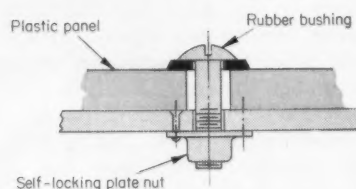
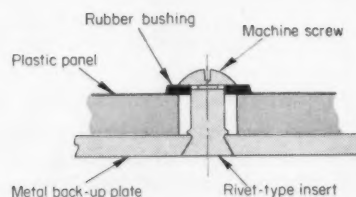
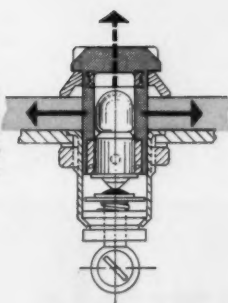


Fig. 1—Methods of attaching plastic panels to metal back-up plates.

scratching the finish from the edges. For the same reasons, all panel edges should have 1/32-in. radii.

Materials and Finishes: Edge-lighted panels are made from clear, transparent plastic—usually acrylic

Fig. 2—Typical lamp assembly for edge-lighted panels. Units can be specified for edge transmission only (solid arrows), or for both edge and direct (dashed arrow) transmission.



—coated with an opaque, nonreflecting black finish except where marking and lettering is required. Finish coating consists of two layers. First, a white finish is applied directly to the panel, and then a black, photosensitive surface is applied over the white.

The marking areas (letters, numerals, and lines) are then etched by photographic methods. Etching removes only the black surface and leaves the white undercoat. The white markings against the black panel provide good contrast for daylight observation. Red illumination for dark adaptation is obtained by using lamps with red filters.

► Lamp Assemblies

Two basic types of lamp assemblies are commonly used for edge-lighted panels. One requires conventional wiring, and the second connects to printed wiring on the panel. Although the printed-wiring type is more expensive, it offers two important advantages over the conventional type: 1. It requires no space behind the panel. 2. It reduces assembly time.

Lamp assemblies are available for edge transmission only, or for a combination of edge transmission and direct transmission, Fig. 2. In the latter instance, the translucent cap of the assembly allows light to pass through. All caps are removable from the operator's side of the panel to permit convenient relamping.

► Design Methods

The number of lamp assemblies required for a panel depends on the panel size and the number and size of lighted areas. Also to be considered are the components and holes that block light passage. A minimum of two lamps are required for the smallest panel to prevent panel black-out in the event of lamp failure.

Military requirements specify a minimum illumination intensity of 0.50 ft-L for panel marking. To meet this requirement, the maximum distance from a light source to an area to be illuminated is 3 in.

Dials and Knobs: Control devices designed for illumination by edge-lighted panels should be recessed below the panel surface. The edge of the recessed area should be opaqued so that stray light is not visible around the edge of the dial, Fig. 3.



Fig. 3—Mounting for a translucent dial in an edge-lighted panel. Part of recessed area is opaqued to prevent light from appearing under edge of dial.

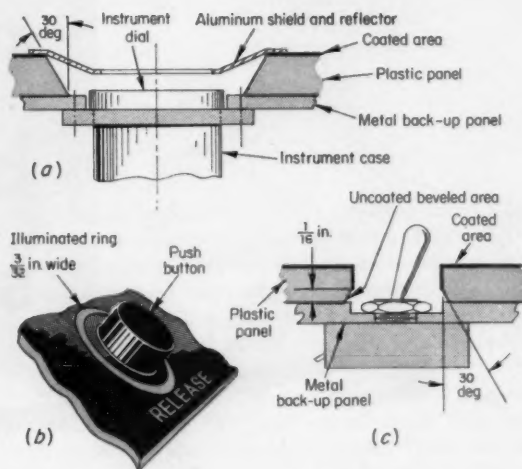


Fig. 4—Methods of illuminating panel components. Instrument dial, *a*, receives reflected light; push button, *b*, is surrounded by illuminated ring; toggle switch, *c*, is illuminated from beveled edge of plastic panel.

Some components that require illumination are not designed for edge-lighted panel application. In such cases, light can be reflected from beveled edges of the panel cutout, or can be made to surround the component, Fig. 4.

Letters, Numbers, and Lines: Identifying numbers or letters on panels should be of the block type, from 1/8 to 5/32 in. high. Larger characters can be used for special emphasis on certain control functions. Following are recommended proportions for letters:

- When space permits, width and height are equal. Minimum width should be 3/5 of the height.
- Line or stroke width and spaces between letters should be about 1/6 of the height.
- Space between words should equal one letter width.

and for numbers:

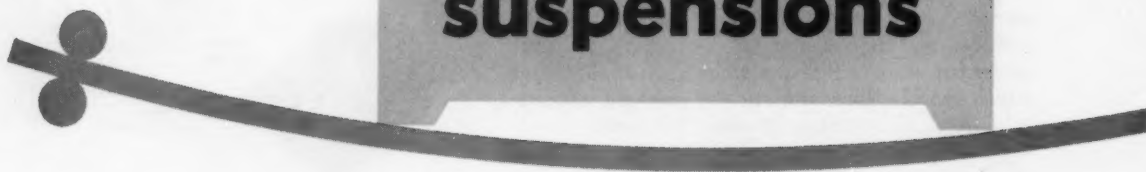
- Width can vary between 4/10 and 7/10 of height, except for the number "4," which should be slightly wider, and the "1," which is one stroke in width.
- Stroke width should be about 1/8 of the height.

Two types of lines used on edge-lighted panels are: 1. Marginal lines around legends and group-control markings. 2. Flow lines to indicate operation flow or sequence.

Marginal lines should be used only when required to prevent confusion between closely spaced adjacent markings. Such lines should be kept thin because they increase the emitted light and tend to distract the operator from functional markings.

designing

flexible beam suspensions



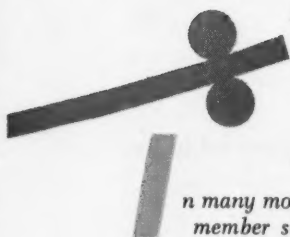
with safe vibration characteristics

1 The problem ...
design approach ...
resonant-frequency charts

2 Precalculated coefficients ...
solution methods ...
design examples

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In many mounting arrangements, the mechanical member supporting a component or assembly often approximates a slender beam. The beam is often much more flexible than the suspended item and may represent only a small portion of the weight of the system. This wide class of designs contains certain resonant frequencies which are responsible for large oscillatory deflections of the suspension in a dynamic environment.

Results of a general analysis of the dynamics of such suspension systems are presented in a previous article (July 6, 1961 issue, p. 134). These results are numerically correlated to indicate important trends and to permit rapid selection of design parameters. How these results are applied to various design situations is shown in this article.

● System Response

A typical set of steady-state sinusoidal response amplitudes for a beam-suspended system is plotted in Fig. 13 as a function of the input frequency for a particular mechanism. In this system, $\xi = 0.1$, $\kappa = 0.2$, and $\eta = 2.0$. The plots of primary interest here are those for $C = Y_{R2}/Y_{R1} = 1$ (equal input amplitudes). Significance of the plots for other C values will be discussed later in this article.

To obtain the plots for $C = 1$ in Fig. 13, relative amplitudes Y_{R1} and Y_{R2} were calculated with a computer which was programmed to numerically evaluate Equations 13 and 14 in Table 1 (Part 1). How-

ever, manual calculation of the response amplitudes for any other particular system is not difficult. To facilitate such calculations, values of impedance coefficients β for a wide range of design situations are presented in Table 3, page 166. For systems not covered by Table 3, β values can be calculated with the equations given in Table 1.

First step in calculating a set of response curves is to investigate the first and second-mode resonant frequencies for the particular system. These values can be found quickly from Fig. 5 through 10 (Part 1). This information identifies the range of $\omega^2/(EI/MI^3)$ values that should be included in the calculations to bracket the most important effects of dynamic amplifications.

The points used to approximately identify the response curves for the system under consideration are shown in Fig. 13. Four of the points selected are near the resonance values. Seven additional points are used for more complete definition of the response curves, Y_{R1}/Y_E and Y_{R2}/Y_E , at input frequencies removed from either resonance.

For systems with appropriate values of ξ , κ , and η , the corresponding β values can be read directly from Table 3. Then, when suitable values of input frequency ω have been selected, point plots for the response curves can be determined from Equations 13 and 14, Table 1.

Keep in mind that the β values given in Table 3 are valid only for the conditions specified at the outset of this analysis. These values must be recalculated if the design under consideration deviates appreciably from the original assumptions on type of suspension and method of mass support.

Inspection of the response curves, Fig. 13, indicates that the first-mode resonance can be identified mainly with a translational condition of the suspended item. The deflection pattern of the foundation member is similar to that developed under static conditions, although amplitudes are certainly not the same. The first-mode resonance of the foundation is characterized by mild curvature as compared with the second mode. This latter mode is primarily rotary in nature at the location of the suspended item. The mass executes both rotary and translatory motion, with the rotary effect predominating. Caution should be observed in working near this second mode be-

cause it may be influenced substantially by the inertia of the foundation. This effect will be discussed later.

In suspension systems with negligible damping, the maximum bending stresses in the foundation member can be predicted by establishing the bending-moment diagram from forces acting between the suspended mass and the foundation member. These forces, for negligible foundation-mass situations, are given by:

$$F_{R1} = - \frac{\alpha_4}{\alpha_1 \alpha_4 - \alpha_2 \alpha_3} Y_{R1} + \frac{\alpha_2}{\alpha_1 \alpha_4 - \alpha_2 \alpha_3} Y_{R2} \quad (16)$$

$$F_{R2} = - \frac{\alpha_1}{\alpha_1 \alpha_4 - \alpha_2 \alpha_3} Y_{R2} + \frac{\alpha_3}{\alpha_1 \alpha_4 - \alpha_2 \alpha_3} Y_{R1} \quad (17)$$

where influence coefficients α can be calculated from equations given in Table I. The bending stress at the point of maximum oscillatory bending moment induced by F_{R1} and F_{R2} is then determined by ap-

plying the standard stress equation for long beams.¹

Sometimes, the particular problem situation may require the designer to interpret the Y_{R1} and Y_{R2} information to determine motions at other points on the suspended item. For instance, vibrational inputs to a sensitive printed-circuit card mounted in an upper corner of a computer cabinet may be desired, Fig. 14a. Or the dynamic environment at the heater element of a sensitive electronic tube may be of interest to adequately specify a vibrational qualification test for the heater component, Fig. 14b. Transverse vibrational motion Y_P of any point P on the suspended rigid body can be determined from

$$Y_P = \left(1 - \frac{a_P}{a} \right) Y_{R1} + \frac{a_P}{a} Y_{R2} \quad (18)$$

If the foundation end supports can sustain no axial force, the axial vibrational amplitude X_P of any point P on the mass is

$$X_P = \left(\frac{b_P}{a} - \frac{d}{a} \right) (Y_{R2} - Y_{R1}) \quad (19)$$

● Special Design Situations

Design approach and procedures presented in the

¹References are tabulated at end of article.

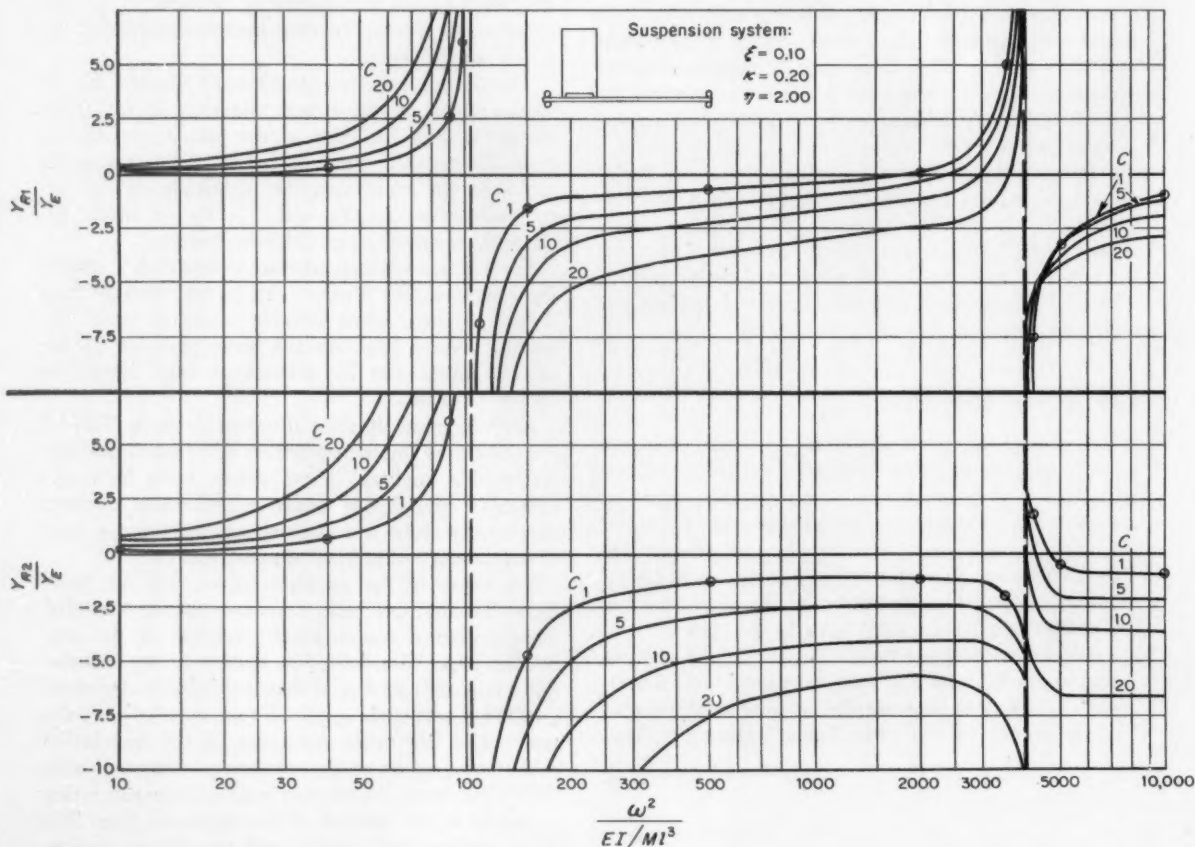


Fig. 13—Steady-state response amplitudes for typical flexible-suspension system. Response curves are plotted as a function of input frequency.

preceding section and Part 1 can also be applied to situations which differ somewhat from the conditions and assumptions originally specified. Various possibilities for the extension of these results are outlined in the following sections.

Variation of Mass Position: Consider first the effect of repositioning the suspended item in a direction normal to the foundation, Fig. 15. If the foundation supports can sustain no axial loads, the new position of the center of gravity does not alter the dynamic response results obtained previously. This condition allows the designer freedom, within practical design limits, to alter the d dimension (Fig. 15) of the rigid mass at a particular foundation mounting position, x , without affecting the dynamic response of the system. Such freedom is often advantageous. For instance, it may provide greater ease in packaging a design.

This characteristic does not apply to foundations which sustain axial load. However, it is valid for any type of foundation mounting arrangement in-

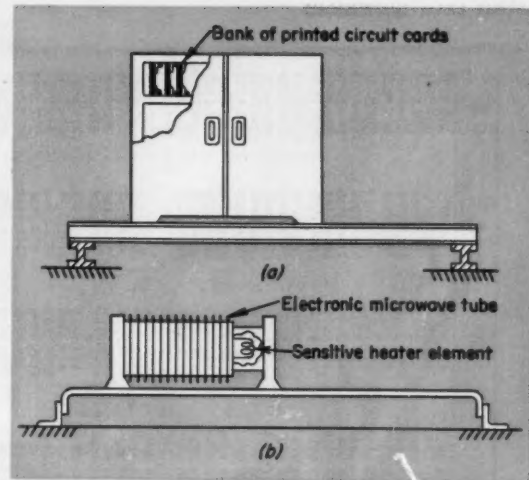


Fig. 14—Design situations requiring interpretation of calculated amplitude values at support points for internal sensitive component: *a*, Printed-circuit cards in computer cabinet; *b*, heater element of sensitive electronic tube.

Nomenclature

a	= Base dimension of suspended item, in.
a_P	= Axial distance from support point R_1 to any point P on the suspended item, in.
b	= Height dimension of suspended item, in.
b_P	= Height of any point P on the suspended item above the foundation, in.
C	= Y_{E2}/Y_{E1} = Amplitude ratio
d	= Height of center of gravity of suspended item above foundation, in.
E	= Modulus of elasticity of beam material, psi
F	= Dynamic force acting between suspended item and foundation, lb
I	= Area moment of inertia of beam cross section about neutral axis, in. ⁴
I_M	= Rotary mass-moment of inertia of suspended item about axis through center of gravity, lb-in.-sec ²
l	= Beam span between support points, in.
M	= $W/386$ = Mass of suspended item, lb-sec ² /in.
m	= $w/386$ = Total mass of foundation members, lb-sec ² /in.
r	= W/w = Weight ratio
t	= Time, sec
W	= Weight of suspended item, lb
w	= Total weight of foundation member, lb
x	= Distance from left beam support point, in.
Y	= Amplitude, in.
y	= $Y \sin \omega t$ = Displacement, in.
α	= Influence coefficient, in./lb
β	= Impedance coefficient
η	= b/a = Shape factor
κ	= a/l = Base size factor
ξ	= x/l = Position factor
ω	= Input frequency to system, rad/sec
ω_n	= First-mode resonance of beam support under the influence of its own weight, rad/sec
ω_{n1}, ω_{n2}	= First and second-mode resonance frequencies of the system, rad/sec
Subscripts	
CG	= Center of gravity of suspended element
E_1, E_2	= Left and right beam supports, respectively
P	= Any point on suspended mass
R_1, R_2	= Left and right support points, respectively, for suspended element

volving only transverse support and free of horizontal constraint (See Fig. 3, Part 1). When foundation supports deviate from the simply supported conditions previously specified a corresponding set of influence coefficients ($\alpha_1, \alpha_2, \alpha_3, \alpha_4$) must be calculated for the particular boundary conditions involved.² Equations 12.1 through 14 (Table 1) can then be used to determine the response for the particular support condition. Here, as before, a change in the d dimension will have no effect upon the calculated values for resonant frequency or dynamic response of the modified support situation.

Axial Foundation Constraint: Let $d = b/2$ with the base of the rigid mass attached directly to the foundation as in Fig. 15a. Any form of axial elastic restraint in the foundation supports, resisting horizontal motion of the foundation relative to its supports, produces resonant frequencies above the values obtained by the procedures detailed here previously. In addition, if the position variable d is diminished, the two system resonances will be further increased, to values above those determined when $d = b/2$. For a given type of axial foundation constraint, the highest resonant frequencies developed will occur when $d = 0$. Consequently, the resonant frequencies determined by the procedures previously given here can be used to approximate the lower limits for all design situations involving axial constraint, and center-of-gravity positions in the range $0 \leq d \leq b/2$. This information is useful in estimating an operating range, below the first resonance, to which a design can be exposed without experiencing excessive amplification.

Independent Foundation Supports: The mutual dependence of the two support point deflections (related through the equal influence coefficients α_2 and α_3) is not present in certain designs, such as the ar-

Table 3—Values of β

ξ	κ	γ	β_1	β_2	β_3	β_4
0.100000	0.100000	2.000000	1947.7200	9360.5120	3218.7524	5071.9305
0.200000	0.200000	2.000000	1792.0734	3700.1955	2256.2300	2735.2607
0.300000	0.300000	2.000000	1694.6515	2415.8372	1874.9585	2055.2785
0.400000	0.400000	2.000000	1601.0350	1801.0908	1751.6616	1751.6755
0.500000	0.500000	2.000000	1521.4970	1265.2544	1638.7574	1638.7574
0.600000	0.600000	2.000000	1456.0748	8167.5158	1265.2544	1265.2544
0.700000	0.700000	2.000000	1407.1522	5633.9582	1093.1104	1093.1104
0.800000	0.800000	2.000000	1370.4577	4416.2286	950.5093	950.5093
0.900000	0.900000	2.000000	1347.2725	3501.4577	850.5282	850.5282
1.000000	1.000000	2.000000	1332.0754	2863.8549	7821.5628	7821.5628
0.100000	0.100000	2.000000	1318.9222	2394.7204	7311.2904	7311.2904
0.200000	0.200000	2.000000	1296.2260	2000.7908	6800.7908	6800.7908
0.300000	0.300000	2.000000	1273.2260	1690.4248	6380.4248	6380.4248
0.400000	0.400000	2.000000	1250.2260	1450.0137	6020.0137	6020.0137
0.500000	0.500000	2.000000	1227.2260	1260.0137	5720.0137	5720.0137
0.600000	0.600000	2.000000	1204.2260	1100.0137	5460.0137	5460.0137
0.700000	0.700000	2.000000	1181.2260	960.0137	5220.0137	5220.0137
0.800000	0.800000	2.000000	1158.2260	840.0137	5000.0137	5000.0137
0.900000	0.900000	2.000000	1135.2260	730.0137	4800.0137	4800.0137
1.000000	1.000000	2.000000	1112.2260	630.0137	4620.0137	4620.0137
0.100000	0.100000	2.000000	1089.2260	540.0137	4460.0137	4460.0137
0.200000	0.200000	2.000000	1066.2260	460.0137	4310.0137	4310.0137
0.300000	0.300000	2.000000	1043.2260	390.0137	4170.0137	4170.0137
0.400000	0.400000	2.000000	1020.2260	330.0137	4040.0137	4040.0137
0.500000	0.500000	2.000000	997.2260	270.0137	3920.0137	3920.0137
0.600000	0.600000	2.000000	974.2260	210.0137	3810.0137	3810.0137
0.700000	0.700000	2.000000	951.2260	150.0137	3710.0137	3710.0137
0.800000	0.800000	2.000000	928.2260	90.0137	3620.0137	3620.0137
0.900000	0.900000	2.000000	905.2260	30.0137	3540.0137	3540.0137
1.000000	1.000000	2.000000	882.2260	-30.0137	3470.0137	3470.0137
0.100000	0.100000	2.000000	859.2260	-70.0137	3410.0137	3410.0137
0.200000	0.200000	2.000000	836.2260	-110.0137	3360.0137	3360.0137
0.300000	0.300000	2.000000	813.2260	-150.0137	3320.0137	3320.0137
0.400000	0.400000	2.000000	790.2260	-190.0137	3290.0137	3290.0137
0.500000	0.500000	2.000000	767.2260	-230.0137	3260.0137	3260.0137
0.600000	0.600000	2.000000	744.2260	-270.0137	3230.0137	3230.0137
0.700000	0.700000	2.000000	721.2260	-310.0137	3200.0137	3200.0137
0.800000	0.800000	2.000000	698.2260	-350.0137	3170.0137	3170.0137
0.900000	0.900000	2.000000	675.2260	-390.0137	3140.0137	3140.0137
1.000000	1.000000	2.000000	652.2260	-430.0137	3110.0137	3110.0137
0.100000	0.100000	2.000000	629.2260	-470.0137	3080.0137	3080.0137
0.200000	0.200000	2.000000	606.2260	-510.0137	3050.0137	3050.0137
0.300000	0.300000	2.000000	583.2260	-550.0137	3020.0137	3020.0137
0.400000	0.400000	2.000000	560.2260	-590.0137	2990.0137	2990.0137
0.500000	0.500000	2.000000	537.2260	-630.0137	2960.0137	2960.0137
0.600000	0.600000	2.000000	514.2260	-670.0137	2930.0137	2930.0137
0.700000	0.700000	2.000000	491.2260	-710.0137	2900.0137	2900.0137
0.800000	0.800000	2.000000	468.2260	-750.0137	2870.0137	2870.0137
0.900000	0.900000	2.000000	445.2260	-790.0137	2840.0137	2840.0137
1.000000	1.000000	2.000000	422.2260	-830.0137	2810.0137	2810.0137
0.100000	0.100000	2.000000	399.2260	-870.0137	2780.0137	2780.0137
0.200000	0.200000	2.000000	376.2260	-910.0137	2750.0137	2750.0137
0.300000	0.300000	2.000000	353.2260	-950.0137	2720.0137	2720.0137
0.400000	0.400000	2.000000	330.2260	-990.0137	2690.0137	2690.0137
0.500000	0.500000	2.000000	307.2260	-1030.0137	2660.0137	2660.0137
0.600000	0.600000	2.000000	284.2260	-1070.0137	2630.0137	2630.0137
0.700000	0.700000	2.000000	261.2260	-1110.0137	2600.0137	2600.0137
0.800000	0.800000	2.000000	238.2260	-1150.0137	2570.0137	2570.0137
0.900000	0.900000	2.000000	215.2260	-1190.0137	2540.0137	2540.0137
1.000000	1.000000	2.000000	192.2260	-1230.0137	2510.0137	2510.0137
0.100000	0.100000	2.000000	169.2260	-1270.0137	2480.0137	2480.0137
0.200000	0.200000	2.000000	146.2260	-1310.0137	2450.0137	2450.0137
0.300000	0.300000	2.000000	123.2260	-1350.0137	2420.0137	2420.0137
0.400000	0.400000	2.000000	100.2260	-1390.0137	2390.0137	2390.0137
0.500000	0.500000	2.000000	77.2260	-1430.0137	2360.0137	2360.0137
0.600000	0.600000	2.000000	54.2260	-1470.0137	2330.0137	2330.0137
0.700000	0.700000	2.000000	31.2260	-1510.0137	2300.0137	2300.0137
0.800000	0.800000	2.000000	8.2260	-1550.0137	2270.0137	2270.0137
0.900000	0.900000	2.000000	-14.7740	-1590.0137	2240.0137	2240.0137
1.000000	1.000000	2.000000	-37.7740	-1630.0137	2210.0137	2210.0137
0.100000	0.100000	2.000000	-60.7740	-1670.0137	2180.0137	2180.0137
0.200000	0.200000	2.000000	-83.7740	-1710.0137	2150.0137	2150.0137
0.300000	0.300000	2.000000	-106.7740	-1750.0137	2120.0137	2120.0137
0.400000	0.400000	2.000000	-129.7740	-1790.0137	2090.0137	2090.0137
0.500000	0.500000	2.000000	-152.7740	-1830.0137	2060.0137	2060.0137
0.600000	0.600000	2.000000	-175.7740	-1870.0137	2030.0137	2030.0137
0.700000	0.700000	2.000000	-198.7740	-1910.0137	2000.0137	2000.0137
0.800000	0.800000	2.000000	-221.7740	-1950.0137	1970.0137	1970.0137
0.900000	0.900000	2.000000	-244.7740	-1990.0137	1940.0137	1940.0137
1.000000	1.000000	2.000000	-267.7740	-2030.0137	1910.0137	1910.0137
0.100000	0.100000	2.000000	-290.7740	-2070.0137	1880.0137	1880.0137
0.200000	0.200000	2.000000	-313.7740	-2110.0137	1850.0137	1850.0137
0.300000	0.300000	2.000000	-336.7740	-2150.0137	1820.0137	1820.0137
0.400000	0.400000	2.000000	-359.7740	-2190.0137	1790.0137	1790.0137
0.500000	0.500000	2.000000	-382.7740	-2230.0137	1760.0137	1760.0137
0.600000	0.600000	2.000000	-405.7740	-2270.0137	1730.0137	1730.0137
0.700000	0.700000	2.000000	-428.7740	-2310.0137	1700.0137	1700.0137
0.800000	0.800000	2.000000	-451.7740	-2350.0137	1670.0137	1670.0137
0.900000	0.900000	2.000000	-474.7740	-2390.0137	1640.0137	1640.0137
1.000000	1.000000	2.000000	-497.7740	-2430.0137	1610.0137	1610.0137
0.100000	0.100000	2.000000	-520.7740	-2470.0137	1580.0137	1580.0137
0.200000	0.200000	2.000000	-543.7740	-2510.0137	1550.0137	1550.0137
0.300000	0.300000	2.000000	-566.7740	-2550.0137	1520.0137	1520.0137
0.400000	0.400000	2.000000	-589.7740	-2590.0137	1490.0137	1490.0137
0.500000	0.500000	2.000000	-612.7740	-2630.0137	1460.0137	1460.0137
0.600000	0.600000	2.000000	-635.7740	-2670.0137	1430.0137	1430.0137
0.700000	0.700000	2.000000	-658.7740	-2710.0137	1400.0137	1400.0137
0.800000	0.800000	2.000000	-681.7740	-2750.0137	1370.0137	1370.0137
0.900000	0.900000	2.000000	-704.7740	-2790.0137	1340.0137	1340.0137
1.000000	1.000000	2.000000	-727.7740	-2830.0137	1310.0137	1310.0137
0.100000	0.100000	2.000000	-750.7740	-2870.0137	1280.0137	1280.0137
0.200000	0.200000	2.000000	-773.7740	-2910.0137	1250.0137	1250.0137
0.300000	0.300000	2.000000	-796.7740	-2950.0137	1220.0137	1220.0137
0.400000	0.400000	2.000000	-819.7740	-2990.0137	1190.0137	1190.0137
0.500000	0.500000	2.000000	-842.7740	-3030.0137	1160.0137	1160.0137
0.600000	0.600000	2.000000	-865.7740	-3070.0137	1130.0137	1130.0137
0.700000	0.700000	2.000000	-888.7740	-3110.0137	1100.0137	1100.0137
0.800000	0.800000	2.000000	-911.7740	-3150.0137	1070.0137	1070.0137
0.900000	0.900000	2.000000	-934.7740	-3190.0137	1040.0137	1040.0137
1.000000	1.000000	2.000000	-957.7740	-3230.0137	1010.0137	1010.0137
0.100000	0.100000	2.000000	-980.7740	-3270.0137	980.0137	980.0137
0.200000	0.200000	2.000000	-1003.7740	-3310.0137	950.0137	950.0137
0.300000	0.300000	2.000000	-1026.7740	-3350.0137	920.0137	920.0137
0.400000	0.400000	2.000000	-1049.7740	-3390.0137	890.0137	890.0137
0.500000	0.500000	2.000000	-1072.7740	-3430.0137	860.0137	860.0137
0.600000	0.600000	2.000000	-1095.7740	-3470.0137	830.0137	830.0137
0.700000	0.700000	2.000000	-1118.7740	-3510.0137	800.0137	800.0137
0.800000	0.800000	2.000000	-1141.7740	-3550.0137	770.0137	770.0137
0.900000	0.900000	2.000000	-1164.7740	-3590.0137	740.0137	740.0137
1.000000	1.000000	2.000000	-1187.7740	-3630.0137	710.0137	710.0137
0.100000	0.100000	2.000000	-1210.7740	-3670.0137	680.0137	680.0137
0.200000	0.200000	2.000000	-1233.7740	-3710.0137	650.0137	650.0137
0.300000	0.300000	2.000000	-1256.7740	-3750.0137	620.0137	620.0137
0.400000	0.400000	2.000000	-1279.7740	-3790		

rangement depicted in Fig. 16. The existence of two unequal foundation flexibilities, Fig. 16b, is nevertheless responsible for coupled translatory and rotary modes of motion, which will be excited by a uniform input excitation, $y_{E1} = y_{E2} = Y_E \sin \omega t$.

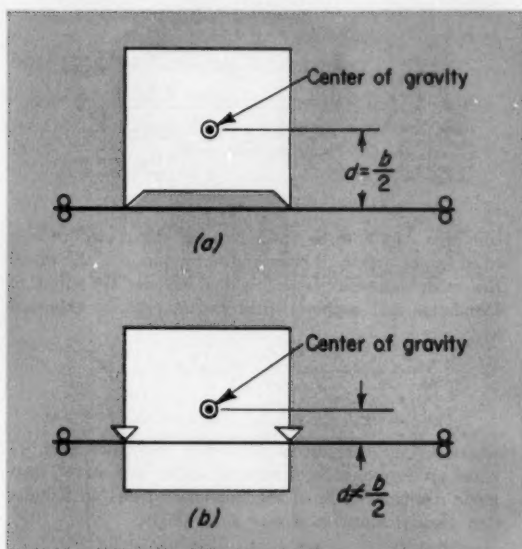


Fig. 15—Variation of position of suspended item in a direction normal to the foundation: *a*, Conventional position of suspended item in which height of center of gravity above foundation is $d = b/2$; *b*, altered position of suspended item in which d dimension is reduced.

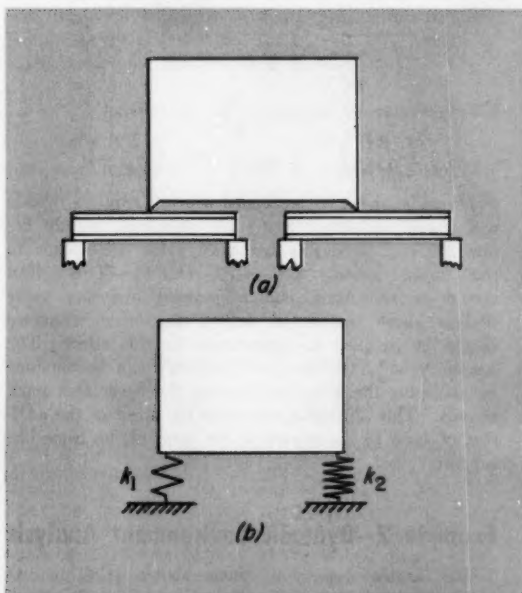


Fig. 16—Suspension system with unequal and independent foundation flexibilities at the points of load application: *a*, Two-support arrangement; *b*, schematic diagram of mass-spring relationships (k_1 and k_2 are spring constants of base).

By elimination of the cross-influence coefficients, α_2 and α_3 , and simplification of coefficients α_1 and α_4 to represent merely the flexibility of each independent base at the point of load application, the β expressions in Table 1 are reduced to:

$$\beta_1 = \frac{1}{2\alpha_4} \left(\frac{2}{M} + \frac{a^2}{2I_M} \right) \quad (20)$$

$$\beta_2 = \frac{1}{2\alpha_1} \left(\frac{2}{M} + \frac{a^2}{2I_M} \right) \quad (21)$$

$$\beta_3 = -\frac{1}{2\alpha_1} \left(\frac{2}{M} - \frac{a^2}{2I_M} \right) \quad (22)$$

$$\beta_4 = -\frac{1}{2\alpha_4} \left(\frac{2}{M} - \frac{a^2}{2I_M} \right) \quad (23)$$

Insertion of these parameters into Equations 12.1 and 12.2, Table 1, will give the two resonant frequencies for the case of independent base supports of different flexibilities.

Unequal Input Amplitudes: For a general analysis, Equations 1, 2, 13, and 14 of Table 1 should be modified to permit prediction of the influence of unequal forcing amplitudes at the foundation supports. This effect may not be important in some situations because it is obscured by phenomena which have been neglected in this analysis. For instance, little value exists in thorough investigation of design responses for a system where $Y_{E2} = 1.05Y_{E1}$. Internal damping within the design may alter the response sufficiently to obliterate the effect of these uneven inputs. Suppose, however, the subject of a design analysis is the dynamic response of a loaded chassis which is mounted at each end to a computer cabinet structure, Fig. 17. Here, the cabinet

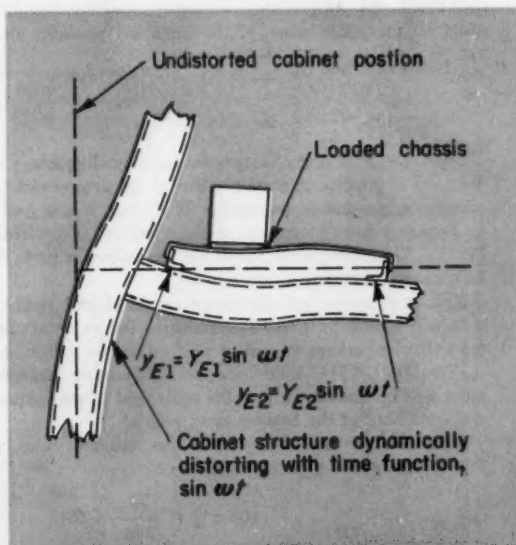


Fig. 17—Loaded chassis in computer cabinet structure which has been excited near one of its natural frequencies. Dynamic distortion of the cabinet induces unequal input amplitudes to flexible chassis at discrete frequency ω .

Example 1—Suspension Design

An equipment package, A, is to be suspended on beam-like support members which are attached to rigid walls by conventional fastening devices. The package can be assumed to be homogeneous and has a total weight of 20 lb. Because of design limitations, the package must be mounted in a confined space with proportions as shown in B. The package may be horizontally located at any position between the two walls.

1. Find the package position which will give the highest first-mode resonant frequency of the suspension system for a given beam support.
2. Calculate the beam cross-sectional rigidity required to produce this first mode resonance at a frequency of 200 cps.
3. Check effect of beam weight on resonances predicted with Fig. 5 through 10 (Part 1).

For this design problem, assume that the beam-like support is attached to the rigid foundation with fasteners that produce negligible resisting moment. If this assumption is correct, Fig. 5 through 10, Part 1, can be used to predict system resonances with satisfactory accuracy. However, if the fasteners can transmit moments, the resonances predicted from the charts will represent lower limits for the beam-mass resonances, neglecting foundation (beam) weight. Subsequent adjustment of the resonance predictions will be necessary to account for the effect of foundation weight.

Solution Procedure: Note that the location of the center of gravity of the package may range between the extreme positions 1 and 3. At position 1 (package against left wall), $(x_{cg}/l) = [(3.3/2) - 0.9]/10 = 0.075$; at position 2 (midpoint), $(x_{cg}/l) = 0.5$; and at position 3 (right), $(x_{cg}/l) = 1 - 0.075 = 0.925$. Also, $\eta = (13.3/3.3) = 4.03$ and $\kappa = (3.3/10) = 0.33$.

Maximum first-mode resonant frequencies of suspension systems within the given geometric limitations can now be investigated using Fig. 5 through 10. In this situation, where $\kappa = 0.33$, Fig. 7 applies and should provide sufficient accuracy without interpolation. From Fig. 7, ordinates for the x_{cg}/l values of the three key positions are:

$$\begin{array}{cc} \text{Positions 1 and 3,} & \text{Position 2,} \\ \frac{\omega_{n1}^2}{EI/Ml^3} \approx 49 & \frac{\omega_{n1}^2}{EI/Ml^3} \approx 65 \end{array}$$

Thus, the maximum first-mode resonant frequency is obtained at position 2, corresponding to the symmetrically oriented suspension arrangement. This result is also readily apparent from inspection of the curve for $\eta = 4$ in Fig. 7. Thus, position 2 represents the optimum package location for this suspension design.

Next step is to find the beam cross-sectional rigidity that will produce a first-mode resonant frequency of 200 cps with the package located at position 2. By definition, $\omega_{n1} = 200 (2\pi) = 400 \pi$ rad/sec. Mounting arrangement will be assumed to give the equivalent of pin-jointed end conditions at the beam-support points.

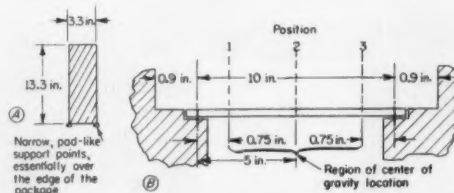
From the previous equation for the ordinate value of Fig. 7, corresponding to position 2,

$$\begin{aligned} I &= \frac{\omega_{n1}^2 M l^3}{65 E} = \frac{(400 \pi)^2 \left(\frac{20}{386} \right) 10^3}{65 E} \\ &= \frac{1.26 \times 10^6}{E} \end{aligned}$$

For a steel beam, $I = (1.26 \times 10^6)/(30 \times 10^6) = 0.042$ in.⁴, and for an aluminum beam, $I = 0.126$ in.⁴

The specific beam section that will supply the required area moment of inertia can now be selected. Assume that two rectangular-section aluminum beams are used, each with a 1 in. width and 0.91 in. depth. These beams will provide a combined area moment of inertia of 0.126 in.⁴, and a combined weight of 2.28 lb.

Effect of foundation weight on the predicted resonance



condition can now be checked using the procedure outlined in the article. Lower and upper limits of the actual first-mode resonance, $\omega_{n1,a}$, which includes the effect of foundation and supported-item inertias, can be expressed as

$$\frac{1}{\frac{1}{\omega_{n1,p}^2} + \frac{1}{\omega_n^2}} \leq \omega_{n1,a}^2 \leq \omega_{n1,p}^2$$

where $\omega_{n1,p}$ = predicted first-mode resonance (Fig. 7) based on suspended-item mass M alone, and ω_n = first-mode resonance of unloaded foundation based on foundation (beam) mass m alone.⁶ Accordingly,

$$\begin{aligned} \omega_{n1,p}^2 &= 65 \frac{EI}{Ml^3} \\ \omega_n^2 &= 97.4 \frac{EI}{ml^3} = 97.4 \frac{M}{m} \frac{EI}{Ml^3} \end{aligned}$$

Also, $M/m = 20/2.28 = 8.75$. Rearranging the terms of the previous bounding expression,

$$\frac{\omega_{n1,p}^2}{\left(\frac{\omega_{n1,p}}{\omega_n} \right)^2 + 1} \leq \omega_{n1,a}^2 \leq \omega_{n1,p}^2$$

Substituting values and taking the square root,

$$7.7 \left(\frac{EI}{Ml^3} \right)^{1/2} \leq \omega_{n1,a} \leq 8.05 \left(\frac{EI}{Ml^3} \right)^{1/2}$$

The foundation weight associated with the required rigidity will lower the actual first-mode resonance slightly below 200 cps, since this frequency value corresponds to the upper bound, $8.05 [(EI)/(Ml^3)]^{1/2}$. This effect should be recognized, and a resonant frequency value slightly above the actual desired first-mode resonance should be assigned to compensate for this effect. The specific value of the adjusted frequency can be obtained by analyzing the difference between the lower and upper bounds. This difference represents the effect of the addition of mass to the system in the form of the beam-like support.

Example 2—Dynamic Environment Analysis

The flexible suspension system shown at C is subjected to a steady-state vibration environment. Total cabinet weight, $W = 2000$ lb, is uniformly distributed. Foundation structure consists of 3 parallel shipboard-type steel beams. Each beam weighs 17.25 lb per running foot. For each beam cross section, $I = 26$ in.⁴ Frequency of input vibration at both supported beam ends

Examples

is 30 cps and

$$y_{R1} = 0.010 \sin 60 \pi t$$

$$y_{R2} = 0.030 \sin 60 \pi t$$

Determine the vertical vibration environment in the upper right corner of the cabinet. This position has been tentatively selected as the mounting location for a highly sensitive electronic component.

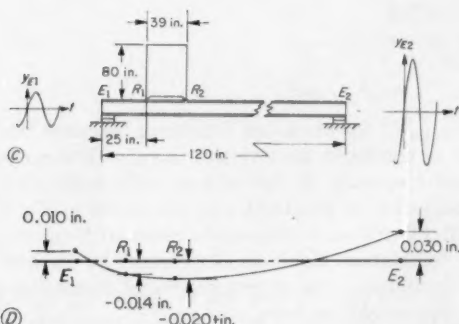
First step is to evaluate the various dimensionless coefficients: $\xi = 25/120 = 0.21$; $\kappa = 39/120 = 0.325$; $\eta = 80/39 = 2.05$; and $C = 0.030/0.010 = 3$. Also, from Equations 31, 32, and 33,

$$\gamma = 1 + 0.21(3 - 1) = 1.42$$

$$\Omega = 1 + 0.21(3 - 1) + 0.325(3 - 1) = 2.07$$

$$\theta = 1 + 0.21(3 - 1) + \frac{0.325}{2}(3 - 1) = 1.75$$

Resonant Frequency Prediction: From the layout at C, $(x_{ca}/l) = \xi + \kappa/2 = 0.21 + 0.163 = 0.373$. First-mode resonant frequency of the system can now be found



from Fig. 5 through 10. Fig. 7 ($\kappa = 0.333$) will be used and should be sufficiently accurate without interpolation. From Fig. 7, using the plot for $\eta = 2$ as a reasonable approximation of this geometric shape,

$$\frac{\omega_{n1}^2}{EI/MI^3} \approx 70$$

Next step is to check the effect of foundation inertia on this resonance prediction. Weight ratio $r = 3.87$. Lower bound for the actual first-mode resonance is

$$\frac{\omega_{n1,p}^2}{\left(\frac{\omega_{n1,p}}{\omega_n}\right)^2 + 1} = 59 \frac{EI}{MI^3}$$

Thus, the limit conditions can be expressed as

$$59(261) \leq \omega_{n1,a}^2 \leq 70(261)$$

where $EI/(MI^3) = 261$. Taking the square root and applying the relationship, $f = \omega/(2\pi)$,

$$19.8 \text{ cps} \leq f_{n1,a} \leq 21.5 \text{ cps}$$

which is a reasonably good definition of $f_{n1,a}$. Thus, the oscillatory environment will induce dynamic distortion of the base since resonance conditions in this situation are primarily dependent on the inertia of the cabinet. This conclusion is based on the small difference between limit values.

Oscillatory Amplitude: Design situations of this nature

readily permit prediction of oscillatory amplitudes because foundation deflection is influenced principally by the rigid suspended element, and secondarily by foundation inertia. Since the character of the first-mode resonance is essentially governed by the inertia of the rigid suspended element (as indicated by the minor influence of foundation inertia on resonant frequency), a first approximation for foundation deflection can be obtained with Equations 26 and 27, disregarding the additional deflection produced in foundation by its own inertial loading.

From Table 3, for $\xi = 0.2$, $\kappa = 0.333$, and $\eta = 2$ (which reasonably approximate this system configuration), $\beta_1 = 210.6$, $\beta_2 = 662.5$, $\beta_3 = 238.1$, and $\beta_4 = 351.1$. Substituting these values into Equations 26 and 27 gives $Y_{R1}/Y_R = -1.42$ and $Y_{R2}/Y_R = -2.07$. Consequently, the foundation deflection pattern at maximum deflection appears approximately as shown at D.

A refinement on this mode shape can be included by superimposing an approximate inertia loading on the beam-like foundation separately, determining the static deflections, and superimposing these deflections upon those just determined. This technique is permissible at frequencies for which the foundation inertia is not primarily responsible for dynamic amplifications, such as the system under consideration, and is generally acceptable at frequencies below and in the neighborhood of the first-mode resonance.

Application of this technique to the system being analyzed is demonstrated at E. The theoretical foundation-deflection curve represents a plot of the form, $y = f(x)$. It is drawn as an approximate curve adapted to conform to the deflection points indicated. The inertia-loading curve is an incremental plot. The vertical increment lines represent the inertia loading per unit length imposed upon the "static" beam to induce deflections associated with foundation inertia. Inertia loading per unit length is

$$\frac{w}{gl} \omega^2 [y(x)]$$

where g = acceleration of gravity (386 in./sec^2), and $\omega = 30 (2\pi) \text{ rad/sec}$ for this system.

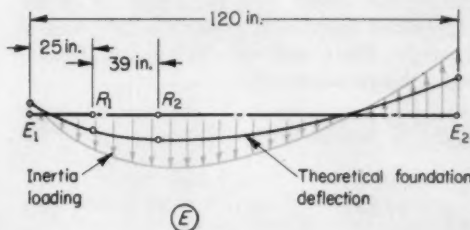
If this modification is disregarded, a first approximation for the vibration severity in the upper right corner of the cabinet can be obtained from Equation 18. In the system layout at C, note that $a_P/a = 1$. Also, from the deflection plot at D, $Y_{R1} = -0.014 \text{ in.}$ and $Y_{R2} = -0.020 \text{ in.}$ Substituting these values in Equation 18,

$$Y_P = (1 - 1)Y_{R1} + (1)Y_{R2} = Y_{R2} = -0.020 \text{ in.}$$

where Y_P = amplitude at upper right corner of cabinet. This result, $Y_P = Y_{R2}$, is to be expected as a consequence of the linear theory upon which this method of analysis is based.

Thus, the vertical vibratory environment at the upper right corner can be defined in terms of gravity units as

$$\frac{Y_P \omega^2}{386} = \frac{0.020 [(30)(2\pi)]^2}{386} = 1.87 g$$



has been excited by inputs near one of its natural modes, inducing motions at the chassis support such that

$$y_{E1} = 0.001 \sin \omega t$$

$$y_{E2} = -0.020 \sin \omega t$$

To predict the chassis response, Equations 1, 2, 13, 14, and 15 of Table 1 must be modified as follows:

$$\frac{d^2 y_{R1}}{dt^2} + \beta_2 y_{R1} = \beta_4 y_{R2} - \gamma \frac{d^2 y_E}{dt^2} \quad (24)$$

$$\frac{d^2 y_{R2}}{dt^2} + \beta_1 y_{R2} = \beta_3 y_{R1} - \Omega \frac{d^2 y_E}{dt^2} \quad (25)$$

$$\frac{Y_{R1}}{Y_E} = \frac{\omega^2 [\gamma \omega^2 - (\beta_4 \Omega + \beta_1 \gamma)]}{-\omega^4 + (\beta_1 + \beta_2) \omega^2 - (\beta_1 \beta_2 - \beta_3 \beta_4)} \quad (26)$$

$$\frac{Y_{R2}}{Y_E} = \frac{\omega^2 [\Omega \omega^2 - (\beta_2 \Omega + \beta_3 \gamma)]}{-\omega^4 + (\beta_1 + \beta_2) \omega^2 - (\beta_1 \beta_2 - \beta_3 \beta_4)} \quad (27)$$

$$Y_{CG} = \Theta Y_E + \frac{Y_{R1} + Y_{R2}}{2} \quad (28)$$

where

$$Y_{R1} = Y_E \quad (29)$$

$$Y_{R2} = C Y_E \quad (30)$$

$$\gamma = 1 + \xi(C - 1) \quad (31)$$

$$\Omega = 1 + \xi(C - 1) + \kappa(C - 1) \quad (32)$$

$$\Theta = 1 + \xi(C - 1) + \frac{\kappa(C - 1)}{2} \quad (33)$$

For the system under study (Fig. 17), with displacements y_{R1} and y_{R2} as previously defined, $Y_E = 0.001$ in. and $C = -20$.

The dynamic response, Equations 26 and 27, can be readily evaluated using the β values tabulated in Table 3. Where necessary, these values are merely modified by the constants Ω and γ .

To demonstrate the effect of end-amplitude variations, the system of Fig. 13 was investigated using a C range from 1 to 20. Results are plotted in Fig. 13 for $C = 1, 5, 10$, and 20.

Influence of Foundation Weight: Dynamic interaction between the weight distribution of the foundation and that of the suspended item can have a significant influence on the vibration characteristics of a suspension system. A brief discussion of these effects is presented here to aid design calculations by the procedures previously discussed.

The effect of the foundation mass is to reduce the resonant frequency values predicted with the charts given in Fig. 5 through 10. The reason for considering the foundation weight in certain situations becomes apparent by inspection of the equation defining the lowest resonant frequency of the simply supported foundation under the influence of its own weight. For a uniformly distributed foundation weight, this resonance is^{5,4}:

$$\frac{\omega_{n1}^2}{EI/m l^3} = 97.4 \quad (34)$$

or

$$\frac{\omega_{n1}^2}{EI/M l^3} = 97.4 r \quad (35)$$

where

$$r = \frac{W}{w} \quad (36)$$

For $r = 10$, it is apparent that the foundation alone would experience an internal first-mode resonance at $\omega_{n1}^2 = 974 EI/(M l^3)$. Certainly, then, for a system where $x_{CG}/l = 0.4$, $\kappa = 0.2$, and $\eta = 1$, the loaded foundation must have a second mode below $[3050 EI/(M l^3)]^{1/2}$, which is the value predicted with the chart in Fig. 6. Here, the actual second-mode resonance of the system assumes more the character of a foundation resonance, modified somewhat by the inertia of the suspended item. A more exact picture of the degree that foundation mass lowers the first mode resonance below the predicted value from the charts in Fig. 5 through 10 is provided by observing the lower boundary on this resonance as defined by Southwell. This lower boundary defines approximately the lowest possible value of the actual first-mode resonant frequency for the combined-mass system. This lower boundary is:

$$\omega_{n1,a}^2 \geq \frac{1}{\frac{1}{\omega_{n1,p}^2} + \frac{1}{\omega_n^2}} \quad (37)$$

where $\omega_{n1,a}$ = lowest actual first-mode resonant frequency of combined mass system; $\omega_{n1,p}$ = first-mode resonant frequency of the system, with foundation mass neglected, as predicted with the charts in Fig. 5 through 10; and ω_n = first-mode resonant frequency of the foundation alone, as determined by its own mass distribution. For simply supported foundations of the type considered here,

$$\omega_n^2 = 97.4 \frac{EI}{m l^3} \quad (38)$$

where m represents the total uniformly distributed foundation mass.

For reliable prediction of the second and higher mode resonances of the combined-mass system, the dynamics of distributed mass systems must be introduced.^{5,6} In such situations, the results obtained from the charts in Fig. 5 through 10 for the massless-foundation system will be of value in refining the analysis to include foundation inertia.

ACKNOWLEDGMENT

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Dynamics of Gas-Operated Mechanisms

Nondimensional graphs simplify calculation of
VELOCITY • DISTANCE • TIME

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IN THE design or the performance analysis of a gas-operated mechanism, the relationship of velocity, distance, and time must often be determined. Frequently, a preliminary analysis is based on the assumption that an initial volume of gas expands, without temperature change, according to the law, $pV^k = C$. See Nomenclature.

Introducing this law into the equation of motion leads directly to the velocity-distance relationship which can be found in many textbooks.

The purpose of this article is to go one step further—to determine the velocity-time relationship. Results are presented in nondimensional parameters to extend their usefulness.

Equation of Motion: When mass M , Fig. 1, is at its initial position ($x = 0$), gas at pressure p_0 and volume V_0 is introduced into the cylinder. The pres-

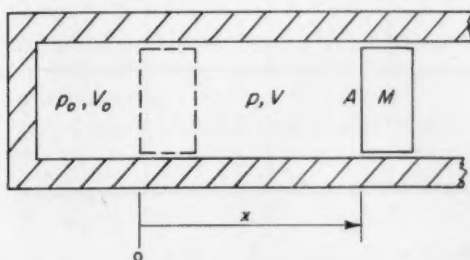


Fig. 1—Schematic diagram of gas-operated mechanism.

sure acts on area A . The motion equation is

$$M \frac{d^2 x}{dt^2} - pA = 0 \quad (1)$$

Equation 1 and the gas law can be combined, rearranged, and integrated to obtain the well-known velocity-distance relationship:

$$v^2 = \frac{2p_0 V_0}{M(k-1)} \left[1 - \frac{1}{\left(1 + \frac{Ax}{V_0}\right)^{k-1}} \right] \quad (2)$$

Equation 2 can be restated in the following nondi-

Nomenclature

- A = Area on which pressure acts, sq in.
- C = Gas-law constant
- k = Gas-law exponent
- M = Mass being accelerated, lb-sec² per in.
- p = Pressure, psi
- p_0 = Initial pressure, psi
- s = Expansion ratio
- t = Time, sec
- u = Fraction of nondimensional velocity attained at a finite expansion ratio
- V = Volume, cu in.
- V_0 = Initial volume, cu in.
- v = Velocity, ips
- v_∞ = Nondimensional velocity attained at infinite expansion
- x = Distance traveled, in.
- τ = Nondimensional time

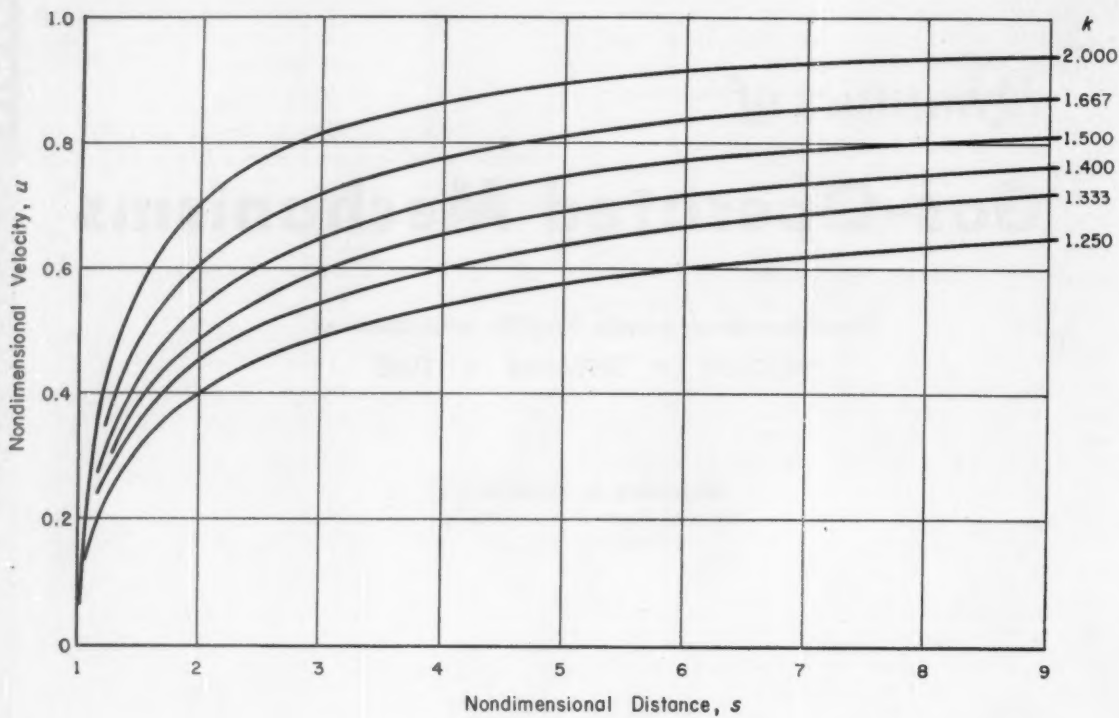


Fig. 2—Nondimensional velocity-distance curves.

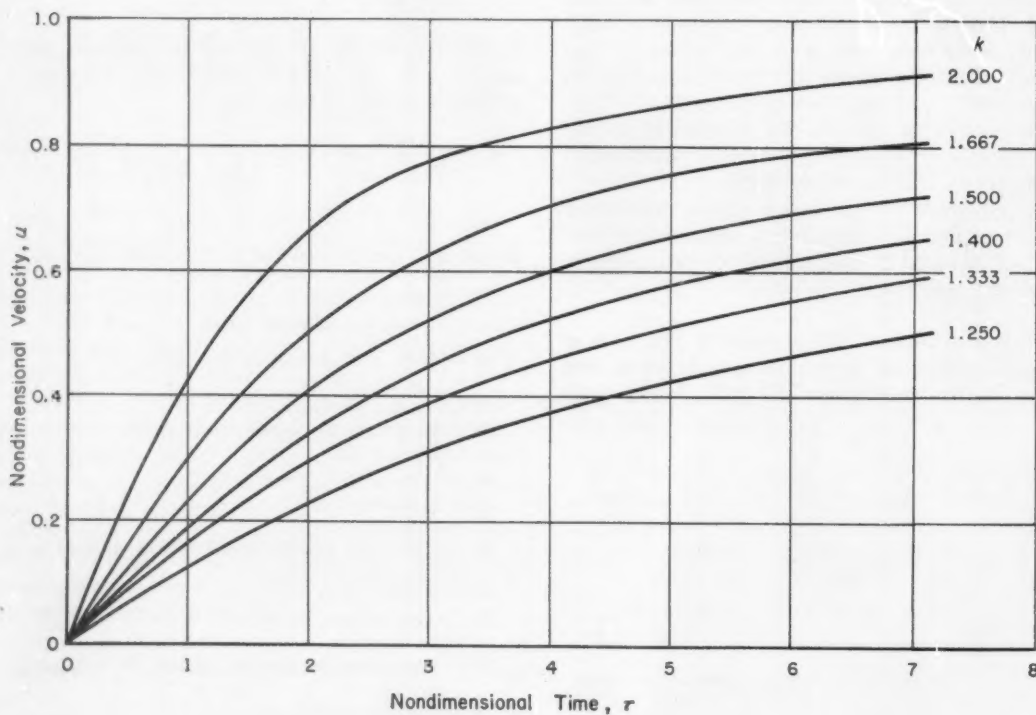


Fig. 3—Nondimensional velocity-time curves.

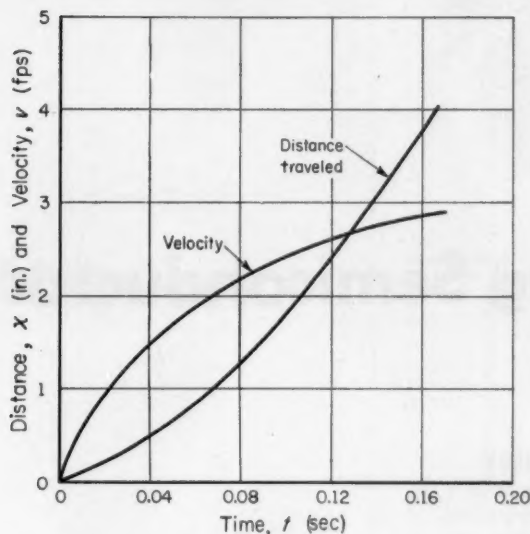


Fig. 4—Velocity and distance curves for example problem.

mensional form:

$$u = \left(1 - \frac{1}{s^{k-1}}\right)^{0.5} \quad (3)$$

where

$$s = 1 + \frac{Ax}{V_0} \quad (4)$$

$$v_x = \sqrt{\frac{2p_0V_0}{M(k-1)}} \quad (5)$$

$$u = \frac{v}{v_\infty} \quad (6)$$

These parameters have definite physical signifi-

Table 1—Parameter Values

s	u	τ	x(in.)	v(fps)	t(sec)
1	0.000	0.00	0	0.00	0.000
2	0.492	3.48	1	2.05	0.069
3	0.597	5.30	2	2.49	0.106
4	0.653	6.85	3	2.72	0.137
5	0.690	8.32	4	2.89	0.166

cance as stated in the Nomenclature. Nondimensional velocity-distance curves for various values of k are shown in Fig. 2.

Next a nondimensional time parameter is introduced:

$$\tau = \frac{Av_\infty}{V_0} t \quad (7)$$

Velocity-Time Relationship: Equation 3 can be differentiated with respect to nondimensional time τ ,

rearranged and integrated to yield

$$\tau = 2(n-1) \int_0^u \frac{du}{(1-u^2)^n} \quad (8)$$

where $n = k/(k-1)$.

The integral of Equation 8 can be readily reduced by the use of standard handbook integral tables, provided n has certain values. Results for various values of k are shown in Fig. 3.

Example: Determine the velocity-time curve for these conditions: $A = 1$ sq in., $V_0 = 1$ cu in., $M = 0.1$ lb-sec² per in., $p_0 = 50$ psi, $k = 1.4$, and maximum displacement = 4 in.

SOLUTION: From Fig. 2 determine the values of u for $s = 2, 3, 4$, and 5 , and $k = 1.4$.

From Fig. 3 determine the values of τ for these values of u .

Equations 4, 5, and 6 can be rearranged and used to convert the values of s , u , and τ to x , v , and t :

$$x = \frac{V_0}{A} (s-1) \quad (9)$$

$$v = u \sqrt{\frac{2p_0V_0}{M(k-1)}} \quad (10)$$

$$t = \frac{V_0}{Av_\infty} \tau \quad (11)$$

Results are shown in Table 1 and Fig. 4, where the velocity data have been converted to feet per second.

They Say . . .

"The basic choice lies not in whether science or the humanities form the better background for a career in [engineering] management, but in the relative degree to which these various facets of knowledge are taught during an undergraduate or a graduate course. Since we cannot hope to complete an education within the ivy halls, the only thing we can do is lay a foundation for future exploration. We cannot hope to make every man a poet, we can only hope to teach him the beauty of language and thought expressed in poetry, hoping as the years go by he will search farther, and possibly find an expression in his own life. So it is with the sciences. We cannot expect to teach a student all science; owing to our tremendously increased rate of accumulation of knowledge we can barely hope to scratch the surface. Those of us who have been out of college a few years recognize that the young men coming out now know far more than we did and learned far more than we ever learned. We can only hope to give them an appetite for future learning."—O. S. CARLISS, Director of Engineering, Materials Handling Div., Yale and Towne Mfg. Co., Philadelphia, Pa.

Techniques for

Packaging Semiconductor

J. S. KILBY

Semiconductor-Components Div.
Texas Instruments, Inc.
Dallas, Tex.

RECENT approaches to semiconductor miniaturization promise complete electronic equipment of extremely small size, light weight, and high reliability. This article describes some of the factors which must be considered in equipment design, and presents one technique which might be used for high-density systems.

Package Requirements: A typical unprotected semiconductor network is shown in Fig. 1. To be useful, this device must be pack-

aged to provide complete mechanical and environmental protection. The package must also include means for bringing electrical connections in and out of the device and some provision for removing heat from the device. The interconnection technique described here provides a design where size and weight have been minimized at the expense of increased cost.

At present, it is essential to build small groups of components which can be assembled to form the complete electronic equipment. Al-

though no exact figures exist, it is believed that the optimum complexity for the individual package is a single functional circuit such as a flip-flop, a logic element, or a gate. The package shown in Fig. 1 is near the upper limit for present circuit complexity. This package contains the equivalent of sixteen components.

A package of uniform size makes it possible to connect the packages together with less wasted space between packages, although some space inside the packages is unused. For this reason, all digital networks made to date have been packaged in the case shown in Fig. 2. This package is assembled as shown in Fig. 3, providing a complete glass-to-metal hermetic seal for full protection of the device under severe military environments. Because of

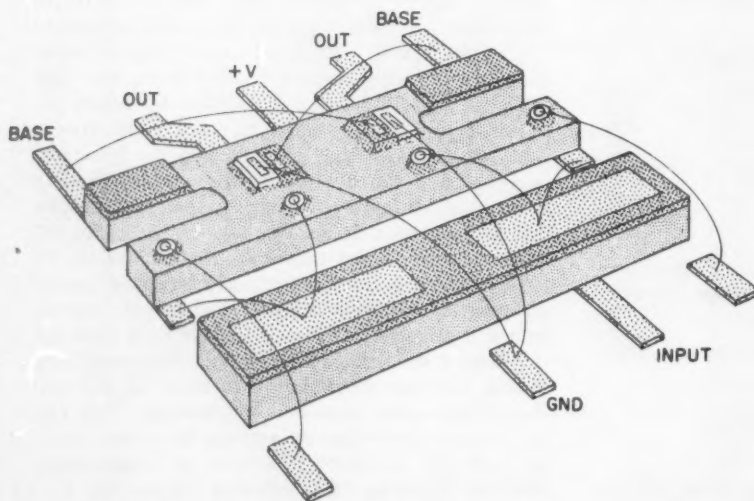


Fig. 1—Bistable multivibrator solid-circuit semiconductor network.

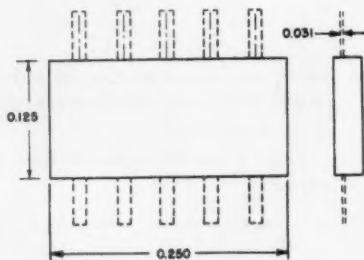


Fig. 2—Hermetically sealed solid-circuit semiconductor network.

Networks

the very small mass of the package, it is not susceptible to mechanical shock.

Wiring Schemes: The thinness of the package makes it possible to connect packages together either by stacking or by the use of flat layouts on an etched circuit board. For either the stacked configuration or the flat version, some form of multiplane wiring is probably essential.

One multiplane wiring scheme which has been used with success is shown in Fig. 4. Here the packages are stacked, and thin sheets of Teflon with metal cladding are used to form the conductors.

It is frequently desirable to separate the supply-voltage wiring, which may be connected to all packages in a stack, from the signal paths which go from package to package. One sheet may be used for each supply voltage. These sheets are formed with a grid pattern of conductors and holes.

The first sheet is placed over the leads of the stack, and the leads to be connected to the sheet are bent over and soldered to the sheet. Electrical and mechanical clearances are provided so that the other leads will pass straight through the sheet and will be insulated from it. A second sheet may then be added and connected. Some of the stacks which have been built have

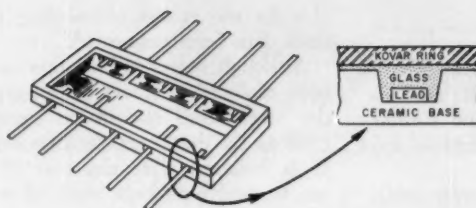


Fig. 3 — Hermetically sealed semiconductor-network package assembly.

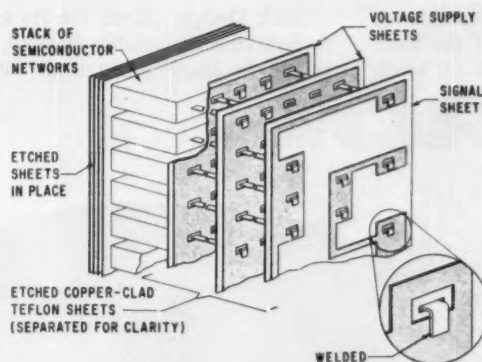


Fig. 4 — Package interconnection.

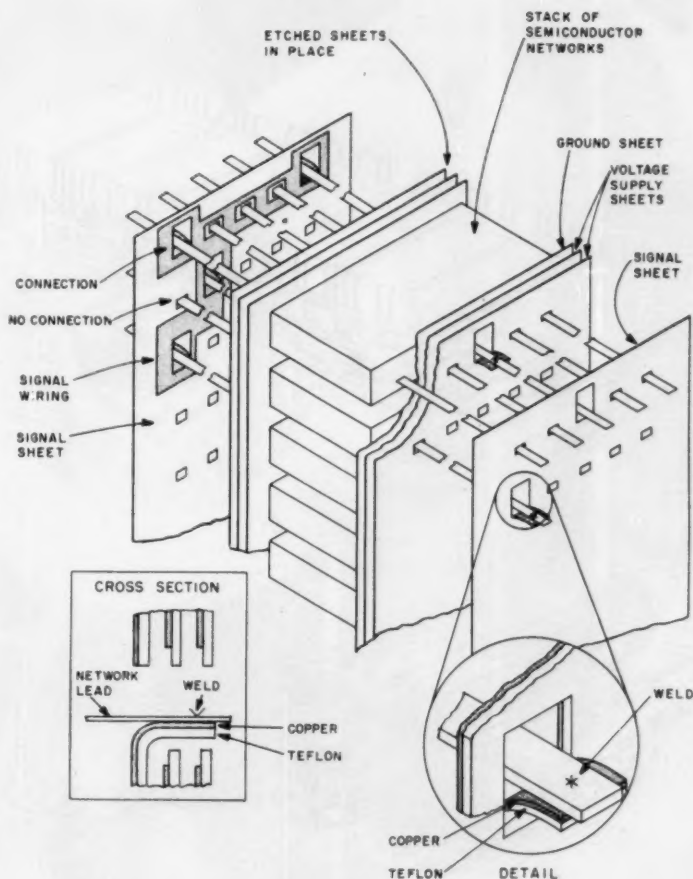


Fig. 5 — Alternate method of semiconductor network interconnection.

used four supply-voltage sheets. The signal paths which are required are then formed on similar etched sheets which complete the remaining connections.

An alternate type of construction is shown in Fig. 5. Here, the Teflon sheets have small cut flaps which can be bent to lie parallel to the matching leads. This version is particularly adaptable to welding. No bending of the leads is required, and all leads are avail-

able for use as test points after the stack has been connected.

Although defective packages have been replaced in stacks of this type, the stack itself should be considered as the basic replaceable item. It is believed that the cost of a ten to twelve-package stack of networks will be within the range of military optimum throwaway cost for production quantities of devices.

Stack Design: Since the stack is to form the replaceable element, it should be sturdy enough to with-

stand handling. It should also include a connector to permit easy replacement and isolation of the individual stacks for testing.

One such arrangement is shown in Fig. 6. An aluminum frame is used to hold the packages. The Teflon sheets are used to provide connections between the packages. The ends of these sheets are then formed around the ends of the frames to provide the male portion of a connector. Flat side plates of aluminum are used on the frame to permit heat transfer from the stack. If required, aluminum foil strips may be placed between the packages and brought over to these plates to further reduce the temperature drop between the frames and the device junctions.

Stacks of this type which will accommodate twelve packages are $0.312 \times 0.600 \times 0.200$ in. Connections between stacks are provided by strips of connectors, which utilize a similar multiplane wiring scheme.

A row of ten stacks is shown in Fig. 7. The individual frame side

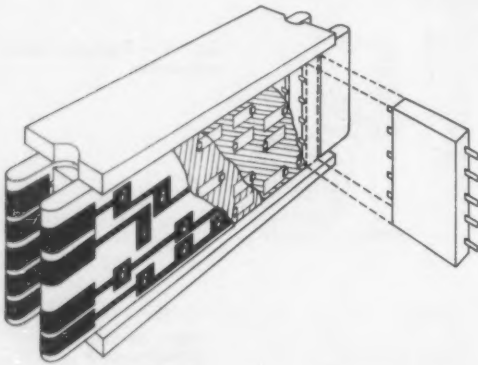


Fig. 6 — Semiconductor network stack.

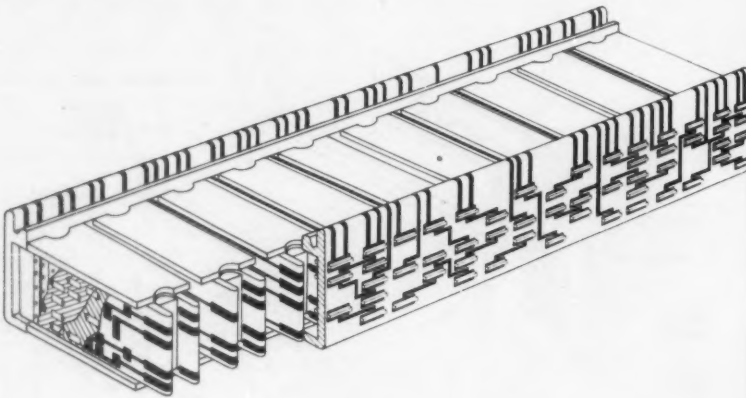


Fig. 7—Semiconductor network row.

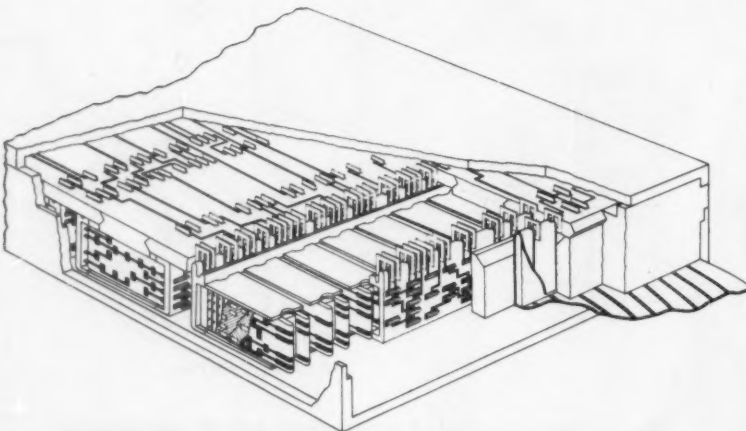
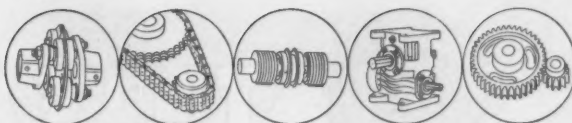


Fig. 8—Semiconductor network equipment assembly.

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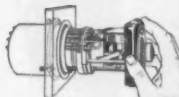


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plates are exposed so that the row can be sandwiched between thermal conductors. The edges of the multiplane wiring are again wrapped around an exposed edge of the strip to provide connections between rows.

These rows may then be plugged in to form large or complete sections of equipment, Fig. 8. Multiplane wiring is used between the connector clips.

An actual assembly of 600 network packages is almost exactly the size of a package of regular cigarettes. It would contain about 8500 individual components in the 600 packages. Total volume required is slightly under 6 cubic inches, including that required for the case, internal heat transfer provisions, and connectors.

This design is not believed to represent the smallest, or the lightest, or the cheapest version possible for this equipment. The real significance of this design is that of an existence theorem—that it is possible to construct useful equipment from semiconductor networks which is orders of magnitude smaller than existing equipment.

Paper entitled, "Interconnection Techniques for Semiconductor Networks," presented at the Joint IRE-AIEE-ACM Computer Conference, Los Angeles, Calif., May, 1961.

materials

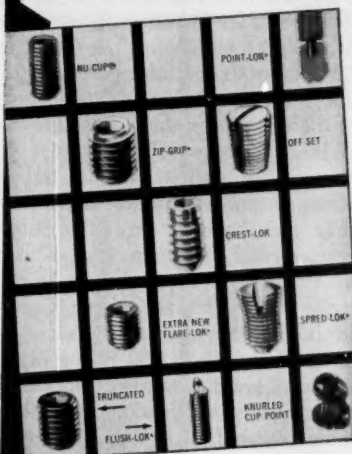
Moduli of Elasticity At High Temperatures

W. H. Hill, Dept. of Welding Engineering, Ohio State University, Columbus, Ohio; and K. D. Shimmin and B. A. Wilcox, Metals and Ceramics Laboratory, Materials Central, Aeronautical Systems Div., Wright-Patterson Air Force Base, Ohio.

Elevated-temperature dynamic moduli of elasticity of 40 commercial metals and alloys at temperatures up to 1800 F. Dynamic modulus measurements were made under conditions of continuous heating at a nominal rate of 12 F per min. Materials tested include aluminum alloys, beryllium, titanium alloys, plain carbon and low-alloy steels, stainless steels, a cobalt alloy, nickel alloys, and refractory metals. Mod-

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ulus measurements presented show variations of modulus as a function of temperature and alloy composition.

ASTM Preprint No. 74, "Elevated-Temperature Dynamic Moduli of Metallic Materials," presented at the Sixty-fourth Annual Meeting of the American Society for Testing Materials, Atlantic City, N. J., June 25-30, 1961, 16 pp. Preprint price, 30 cents.

Tensile and Impact Properties Of Cast Stainless Steels At Cryogenic Temperatures

E. R. Hall, Metallurgist, Esco Corp., Portland, Oregon

Results of tensile and notched-bar impact tests on production heats of seven grades of cast chromium-nickel stainless steels at temperatures from 70 F to -430 F:

1. No ductile-brittle transition was observed for any of the alloys.
2. The tests show the retention of useful ductility and toughness at temperatures as low as -430 F. Tensile strength increases rapidly with decreasing temperature due to the strengthening influence of martensitic ferrite formation during straining.
3. The presence of 0 to 15 per cent delta ferrite dispersed throughout the austenitic microstructure does not result in embrittlement at low temperatures.
4. Low carbon content favors high toughness regardless of whether the carbon is dissolved or precipitated.
5. Lower yield strength-tensile strength ratio at subzero temperatures provides better assurance of toughness than test-dependent values of tensile ductility and notched-bar impact resistance.

ASTM Preprint Number 80f, "Tensile and Impact Properties of Cast Stainless Steels at Cryogenic Temperatures," 9 pp. Preprint price, 30 cents.

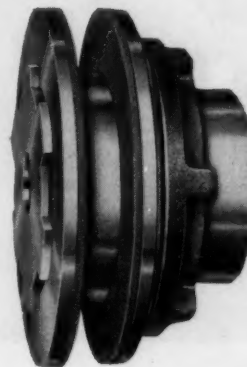
Creep and Rupture of Copper-Base Casting Alloys

Donald P. Moon, principal metallurgist, and Ward F. Simmons, division chief, Metallurgical Dept., Battelle Memorial Institute, Columbus, Ohio

Creep evaluation of cast specimens of 76 Cu-21½ Sn-6½ Pb-15 Zn; 65,000-psi manganese bronze; 110,000-psi manganese bronze; 20 per cent nickel silver; and 81-4-15 silicon brass alloys at temperatures between 250 and 550 F. The duration of the longest tests at each temperature was



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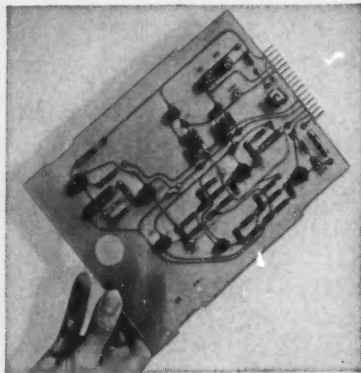
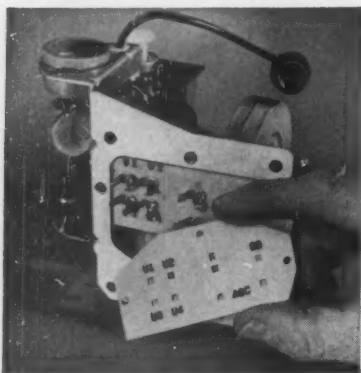
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Taylor glass-base laminates pop right out as design materials in many applications



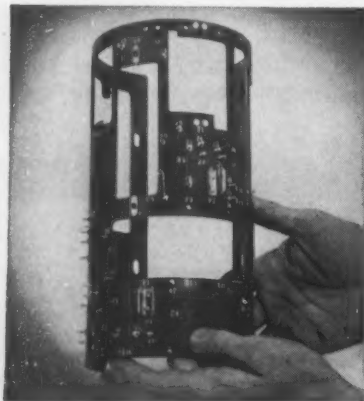
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of different glass-base grades in sheet, rod and tubular form, and copper-clad. Those with phenolic resin are recommended for mechanical and electrical applications requiring heat resistance. Those with melamine are characterized by their excellent resistance to arcing and tracking in electrical applications. They also have good resistance to flame, heat and moderate concentrations of alkalis and most solvents. Those with silicone exhibit very high heat resistance, combined with good mechanical and electrical properties. They also have highest arc resistance. Those with epoxy offer extremely high mechanical strength, excellent chemical resistance, low moisture absorption, and high strength retention at elevated temperatures.

Technical data about these and other Taylor laminated plastics are available. Ask for your copy of the Taylor Laminated Plastics Selection Guide. Taylor Fibre Co., Norristown 47, Pa.



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about 2000 to 3000 hr. The data were correlated with elevated-temperature, short-time tensile data by means of the ASME Boiler and Pressure Vessel Code criteria.

The 76-2 1/2-6 1/2-15 alloy has high creep strength, relative to its short-time tensile strength, up to about 520 F, and its stability is good. The 65,000-psi manganese bronze is limited by its loss of creep strength above 290 F. Prolonged application of the 110,000-psi manganese bronze is limited above 350 F because of the sharp decline of its creep strength and its poor stability above that temperature. For the same reason, the long-time use of the 81-4-15 silicon brass should be restricted to 450 F or lower. Creep in the 20 per cent nickel silver is insignificant up to 550 F; the melting of a lead phase in this alloy prohibits its application at higher temperatures.

ASTM Preprint Number 78, "Creep and Rupture Properties of Five Copper-Base Casting Alloys," presented at the Sixty-fourth Annual Meeting of the American Society for Testing Materials, Atlantic City, N. J., June 25-30, 1961, 18 pp. Preprint price, 50 cents.

electrical

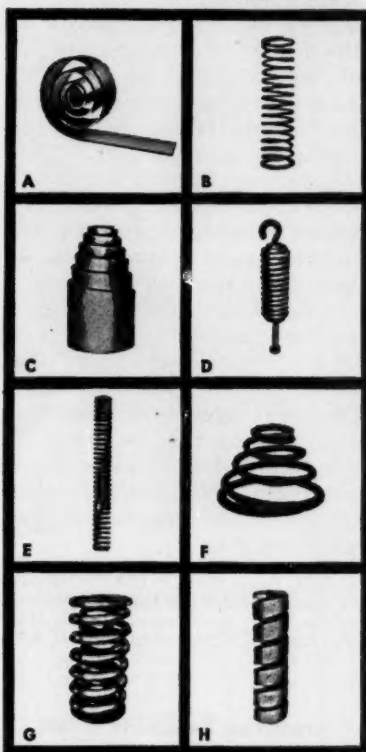
Speed Regulation By Digital Methods

R. R. Potts, Reliance Electric and Engineering Co., Cleveland, Ohio

Application of digital techniques to a precision speed regulation system. The heart of the system is a digital error register. System characteristics include:

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9. Speed accuracy is limited only by the crystal oscillator, and these are available with accuracies to parts-per-million or better.

AIEE Paper No. CP 61-645, "Speed Regulation by Digital Methods," presented at the AIEE Northeastern District Meeting, Hartford, Conn., May, 1961, 9 pp.

techniques

Design of Cryogenic Storage Tanks

Herbert W. Marsh, Chief Engineer, Advanced Designs, Graver Tank and Mfg. Co., Div. of Union Tank Car Co., East Chicago, Ind.

Factors in cryogenic storage tank design for those who have limited experience in this field. Design considerations include cost, suitability of materials for the temperatures and pressures involved, configuration of inner vessels and jackets, support systems, and types of insulation, evacuated and nonevacuated, for both shop-built and field-erected vessels. Potential requirements for cryogenic storage for industrial applications are listed. Military applications for both ground and air-borne use are excluded because they involve unusual design conditions foreign to the usual industrial installation.

ASTM Preprint Number 80e, "Design of Cryogenic Storage Tanks for Industrial Applications," 12 pp. Preprint price, 30 cents.

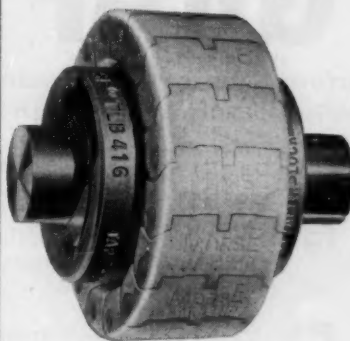
Methods of Analyzing Complex Systems

Ladislav Dolansky, Northeastern University, Boston

Quantitative analysis of complex



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GRAPHITES

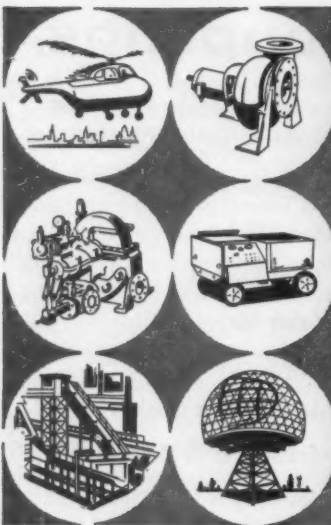
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systems with emphasis on the effects of parts on other parts and on entire systems. Increasing complexity of modern life brings about the development of increasingly complex systems (e.g., traffic or mail sorting in a large city). These systems may or may not include living organisms (e.g., people). Most known methods of analysis, used in the physical sciences, prove inadequate in the analysis of complex systems because of their emphasis on the study of the characteristics of individual elements rather than on the mutual relationships and influences between such elements. In this paper, methods available at the present time for the analysis of complex systems are outlined. Examples of applications, using several disciplines, are given.

AIEE Paper No. CP 61-631, "Methods of Analysis of Complex Systems," presented at the AIEE Northeastern District Meeting, Hartford, Conn., May, 1961, 17 pp.

Predicting Reliability before Availability of Hardware

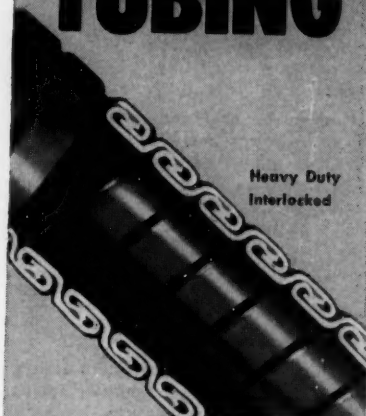
Rene Bussiere, Curtiss-Wright Corp.

Methods for estimating the "strength" and "stress" distributions on the basis of certain design parameters such as blue-print specifications, material properties, and metallurgical or other data. Given a completed design, but no hardware, the reliability of the design can be predicted on the sole condition that it be possible to infer approximations to two statistical distributions or probability density functions:

1. The probability density function of the "strength" of the component. Typically, this could be a property of the material of which the component is made, such as its ultimate tensile strength.
2. The probability density function of the maximum "stress" the component will experience. Typically, this could be the maximum tensile stress in the component resulting from some loading condition, such as the action of a centrifugal field.

Estimation of failure probability, failure rate, or reliability then becomes a matter of straightforward statistical analysis, provided predictions are limited to the useful life of the component, that is, that in-

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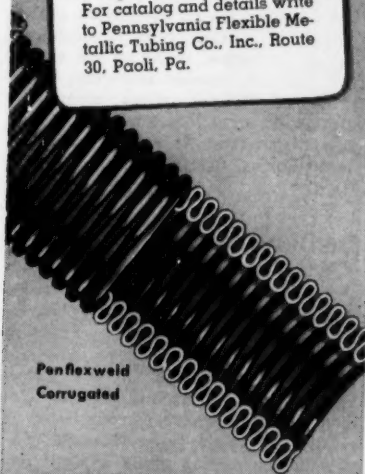


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terval between the "infant mortality" and "wear-out" failure periods, when the hazard rate for most components tends to remain constant.

SAE Paper No. 343A, "A Method of Critiquing Designs and Predicting Reliability in Advance of Hardware Availability," presented at the SAE National Aeronautical Meeting, New York, N. Y., April, 1961, 9 pp.

Dimensional Stability With Ablation

Franklin A. Vassallo, Cornell Aeronautical Laboratory, Inc.

Methods to overcome the difficulties of high-velocity heating:

The first, known as the heat sink method, consists of a heated body of rather high heat capacity material and high thermal conductivity. In this way, the heat introduced is absorbed sensibly and the material remains intact.

A second cooling device is transpiration or mass-transfer cooling. This type of cooling is accomplished by the passage of a coolant material through a heated porous body and, finally, injection of this coolant into the aerodynamic boundary layer. To apply this technique, a coolant supply and a method for mass injection are required.

Another method generally known as ablation cooling makes use of the fact that heat is absorbed by the melting, vaporization, or decomposition of the surface layers of materials.

SAE Paper No. 354B, "Dimensional Stability Together With Ablation," presented at the SAE National Aeronautical Meeting, New York, N. Y., April, 1961, 11 pp.

TO OBTAIN COPIES of paper or article abstracted here, write directly to:

ACM—Association of Computing Machinery, 2 East 63rd St., New York 21, N. Y.

AIEE—American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y.

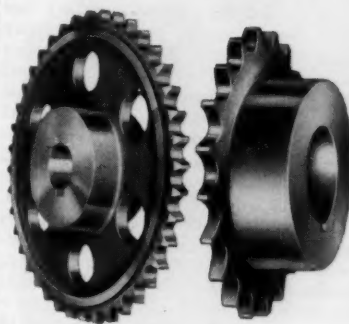
ASTM—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

IRE—The Institute of Radio Engineers, 1 East 79th St., New York 21, N. Y.

SAE—Society of Automotive Engineers, 485 Lexington Ave., New York 17, N. Y., papers 50 cents to members, 75 cents to nonmembers.



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Circle 304 on Page 19

Circle 303 on Page 19

Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Epoxy Pellet Adhesives

Epoxy E-Form adhesive pellets are solid, one-component, premeasured epoxy resins. Information Bulletin 6 describes bond strength, thermal, electrical, and chemical characteristics, production-line bonding techniques, and curing. Typical applications for epoxy adhesives are described in terms of bonding problem and solution. Emphasis is placed on the bonding of dissimilar, hard-to-bond materials. Check list at the end of the bulletin aids in correctly specifying epoxy pellet adhesives. 4 pages. Epoxy Products Inc., Div., Joseph Waldman & Sons, 137 Coit St., Irvington, N. J.

Circle 501 on Page 19

Wire-Wound Resistors

All technical data, performance curves, and photographs on Davohm and Super Davohm precision resistors are included in new catalog. Catalog also includes a discussion of high-reliability resistor program and a cross-reference chart with military specifications. 20 pages. Daven Co., Livingston, N. J.

Circle 502 on Page 19

Thermocouple Material

Processes used to produce Tempak thermocouple material are described in Catalog 2550. Catalog includes specifications and descriptive data on the metal-sheathed ceramic-insulated wire. 8 pages. Temptron Inc., 7030 Darby Ave., Reseda, Calif.

Circle 503 on Page 19

Pressure Regulator

Sensitive pressure regulator is available in ductile iron or bronze in 1/4, 3/8, 1/2, and 3/4-in. sizes, and accommodates steam, water, air, oil, gas, or chemicals. Complete engineering information, test results, photographs, features, and prices are shown in Catalog J160-1. 8 pages. OPW-Jordan, 6013 Wiehe Rd., Cincinnati 37, Ohio.

Circle 504 on Page 19

Designing with Steel

"New Concepts in Steel Design and Engineering," contains four papers which discuss continuing advances in the strength levels, product forms, and design applications of constructional steels. Illustrations and descriptions of many actual designs and design concepts show how these steels can be used in structures and equipment to achieve high strength, light weight, and low costs. Although aimed primarily toward constructional applications, basic data can also be applied to other fields.

60 pages. Market Development Div., U. S. Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.

Circle 505 on Page 19

Worm-Gear Jacks

Worm-gear screw jacks for leveling, adjusting, and stabilizing machinery and equipment are described in new catalog. Descriptive data on the 2, 5, 10, 15, and 25-ton capacity models, typical drive arrangements, dimension drawings, and specifications on speeds, loading, and horsepower/torque requirements are included, as well as design tips, detailed engineering data, and a complete parts list. About 24 pages. Joyce-Cridland Co., 2027 E. First St., Dayton 3, Ohio.

Circle 506 on Page 19

Linear Accelerometers

Performance data on two models of subminiature linear accelerometers, and a brief summary of basic accelerometer principles are contained in new bulletin. Also included are photographs, outline drawings, and cutaway views of the units. 4 pages. Fairchild Controls Corp., 225 Park Ave., Hicksville, L. I., N. Y.

Circle 507 on Page 19

Temperature Regulators

Complete engineering information and technical data on temperature regulators, available in self or pilot-operated models from 1/4 through 6-in. sizes, are included in Catalog TCV-1. Catalog shows cutaway pictures, features, names of parts, ratings, dimensions, applications, operation, ranges, materials of construction, sample specifications, flow curve, and sizing charts. 8 pages. OPW-Jordan, 6013 Wiehe Rd., Cincinnati 13, Ohio.

Circle 508 on Page 19

Bearing Material

Bronze Case for guide rods and piston rods, in combination with hardened-steel bushings, increases life of these working parts. Bulletin lists advantages, specifications sizes. 2 pages. Thomson Industries Inc., 1029 Plandome Rd., Manhasset, N. Y.

Circle 509 on Page 19

Centrifugal Castings

New bulletin points out the advantages of centrifugal castings and explains the investment-casting process. Special processes are also covered. Materials used—non-ferrous alloys and heat, corrosion, and abrasion-resistant alloys—are fully described and listed in two large charts

giving government and society designations, chemical analysis, and minimum physical and mechanical properties. Also listed are nickel-base cast alloys, cobalt-base cast alloys, and alloy, ductile, and Ni-Resist irons. 16 pages. Janney Cylinder Co., 7401 State Rd., Holmesburg, Philadelphia 36, Pa.

Circle 510 on Page 19

Audio Transistors

Two series of milliwatt audio transistors are intended for general-purpose applications in the audio-frequency range, including both amplifier and switching service. Typical turn-on and turn-off time is 2 μ sec. Electrical and mechanical specifications, curves, and dimensional data on the two series are included in Form DS 4009. 4 pages. Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix, Ariz.

Circle 511 on Page 19

Speed Reducers

Latest information on Jones horizontal and vertical spiral-bevel speed reducers is contained in Bulletin J-25. Data includes information on basic types, special features of vertical types, applications, selection procedure, overhung and thrust-load capacities, standard assemblies, horsepower and thermal ratings, general dimensions, backstop selection, and bed-plate dimensions. 34 pages. Dept. SR, Hewitt-Robins, Stamford, Conn.

Circle 512 on Page 19

Precision Springs

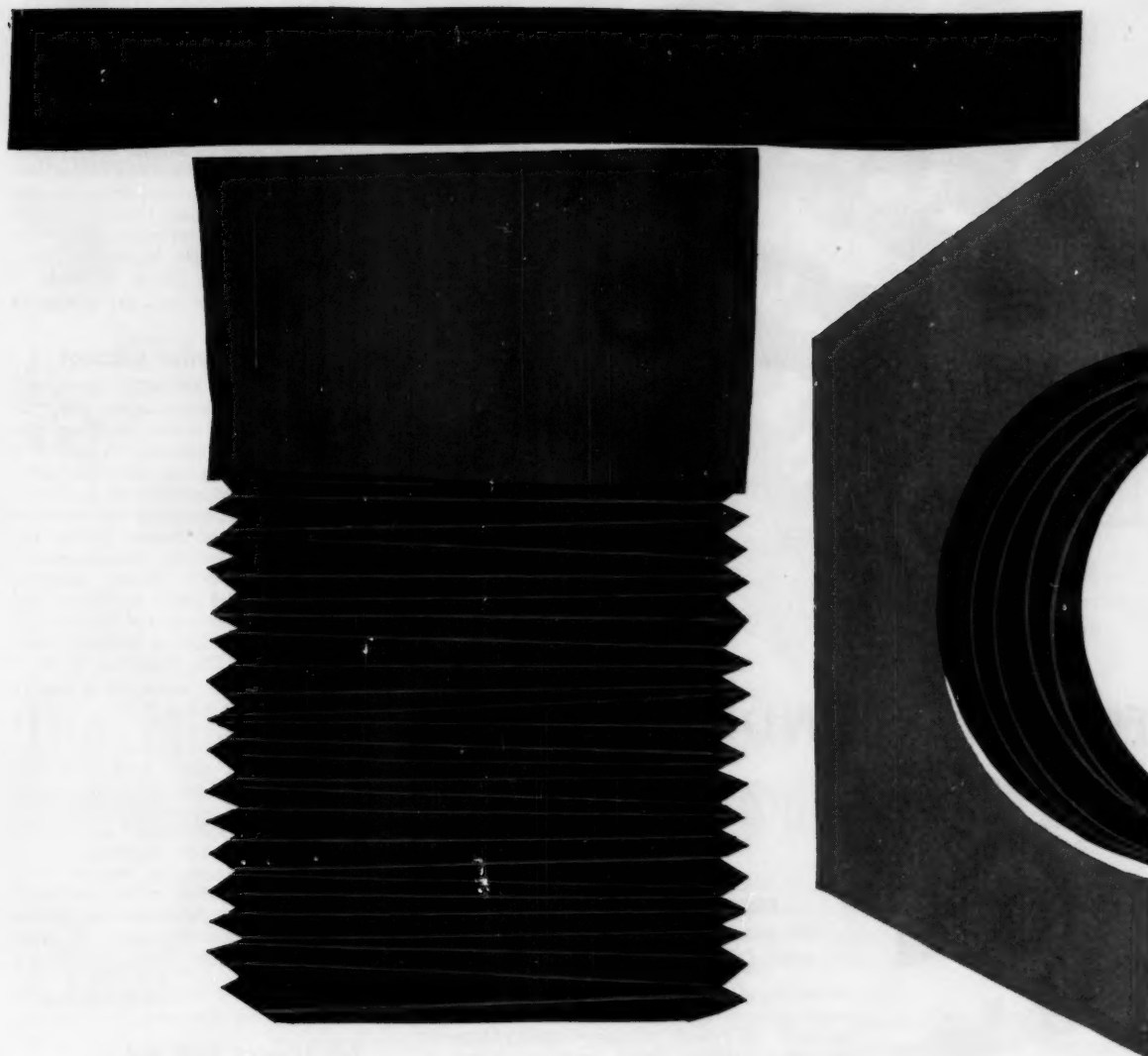
Fully illustrated with samples, new brochure discusses the features of precision springs including simple compression, extension, and torsion springs to Belleville, wave, and finger-type washers. Four-slide parts (both round and flat wire forms) and nonferrous specialties are also covered. Design formulas are explained in detail, and other reference material valuable in determining spring needs is presented in graph and table form. 16 pages. Timms Spring Co., Elyria, Ohio.

Circle 513 on Page 19

Flexible Belting

Illustrated catalog describes flexible, oriented nylon-polymer core belting. Booklet features comprehensive engineering and application data, including graphs to determine proper type belt, as well as charts for belt width and tension. 12 pages. Extremultus Inc., 130 Coolidge Ave., Englewood, N. J.

Circle 514 on Page 19



imagineering the bold new look at Screw & Bolt that says "infinite design capability." Imagination, coupled with engineering, have led to endless new product design developments in fasteners and other threaded parts ■ Need a new design fastener or threaded part where standard shelf items just won't fit? Clip this ad to your letterhead and Screw & Bolt's sales engineers will put *imagineering* to work for you.

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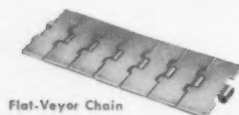
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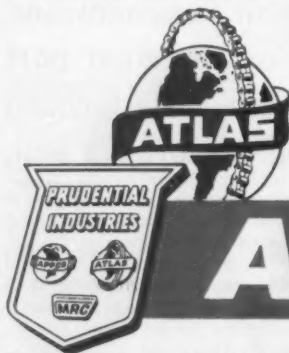
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ATLAS

HELPFUL LITERATURE

Servo Valve

Series SC4 single-stage servo valve for application in electrohydraulic servo systems is described in Bulletin 61-79. Valve is available with a choice of torque motor resistances compatible with electronic, magnetic, or transistor inputs. Bulletin gives complete specifications and valve characteristics. 2 pages. Vickers Inc., Div., Sperry Rand Corp., Detroit 32, Mich.

Circle 515 on Page 19

Electrical Insulation Silicones

"Silicones for Electrical Insulation," CDS-288, incorporates more than 20 photographs and charts providing data and examples of silicones in use in a variety of electrical and electronic applications. Included are sections on silicone varnishes for impregnating and protective coatings, clear and opaque potting and encapsulating materials, pressure-sensitive adhesives, dielectric fluids, dielectric greases, wire and cable insulation, and combination constructions of silicones with other materials. Silicone Products Dept., General Electric Co., Waterford, N. Y.

Circle 516 on Page 19

Flexural Pivot

New Flexural pivot is a frictionless bearing of limited angular travel, having no backlash and requiring no lubrication. Described in Publication 00U-6-613A, unit has applications wherever rotating bearings are required for angular travel to ± 30 deg. Booklet points out design features and lists dimensions and characteristics of standard units. 4 pages. Utica Div., Bendix Corp., 211 Seward Ave., Utica, N. Y.

Circle 517 on Page 19

Self-Aligning Lock Nut

A return to perpendicularity in nut-bolt fastening is urged in a pocket-sized Form 2724. It reviews SA 16 self-aligning locknut that compensates for out-of-square conditions as great as 8 deg. Diagrams illustrate the action of the two-part nut in restoring perpendicularity of bolts in cases of surface misalignment. Effect of bending on bolt fatigue life is described. Folder contains general specification information on the nut, rated at 160,000 psi tensile strength. 6 pages. Standard Pressed Steel Co., Box 102, Jenkintown, Pa.

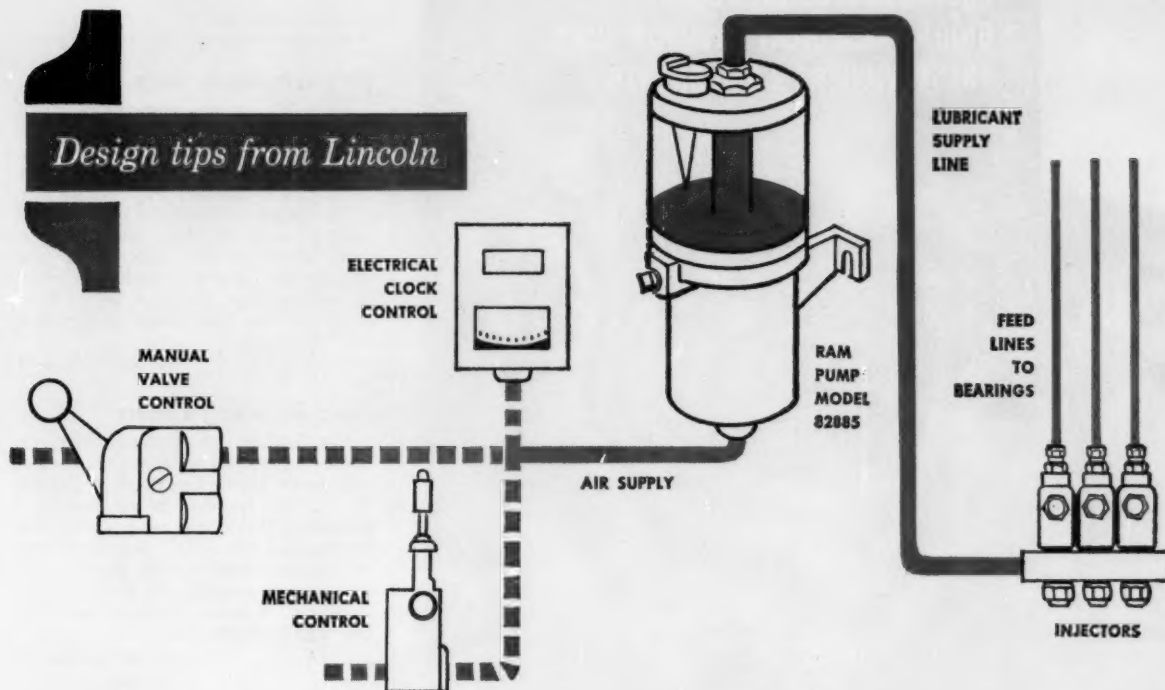
Circle 518 on Page 19

Plugs and Jacks

Designed for quick, tight, space-saving patchwork on panel boards, Cambion miniature connectors provide good contact on conventional or printed circuits. Detailed information, including line drawings and tables, on the 35 basic types of plugs and jacks is given in Catalog 70, which is punched for loose-leaf binders. 16 pages. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Circle 519 on Page 19

Design tips from Lincoln



The "Milkshaker"...new, compact ram pump for low-cost, automatic lubrication on machine tools

You can use Lincoln's new, compact ram pump for automatic or semi-automatic lubrication on machine tools of all types. This unit lets you design all of the advantages of the large centralized lubrication systems into light, medium or heavy machine tools. It pumps grease or oil, comes in air- or hydraulic-operated models, can be cycled manually, electrically or by mechanical linkage. You can use it to cycle Lincoln's lubricant injectors that measure precise amounts of lubricant and deliver it through a single line under high pressure directly into the individual bearings.

You can mount more than one pump on each machine to handle different lubricants or different cycle frequencies. The new ram pump gives you more flexibility in your design than you would think possible in a low-cost unit.

Note to Manufacturers: Lincoln will help you determine the best automatic lubrication system for your machinery. Contact the Original Equipment Sales Division.

MAIL THIS COUPON TODAY!

Ram Pump Model No.	Output Per Stroke	Lubricant	Operating Air Pressure
82885 (Air operated)	.45 cu. in.	Oil	35-50 p.s.i.
82961 (Air operated)	1.6 cu. in.	Oil	95-125 p.s.i.
82886 (Air operated)	.45 cu. in.	Grease or oil	70-125 p.s.i.
83110 (Hydraulic)	.45 cu. in.	Grease or oil	50-200 p.s.i. (Hydraulic)

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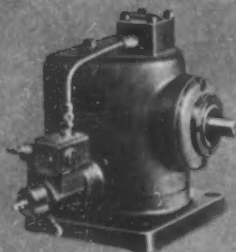
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UNION MACHINERY DIVISION USES
THESE VICKERS COMPONENTS**



CUSTOM POWER PACKAGE—A double-ended 60 hp electric drive motor is the prime mover for the two main hydraulic drives—one powering the developer (30 to 50 hp), the other driving the incorporator (5 to 10 hp). Vickers also supplies auxiliary control valving as part of the complete package. For more details on customized or standard power packages contact your Vickers application engineer.

PISTON PUMPS—AMF's application employs variable-displacement pumps having electrical remote volume control. Industry's broadest standard line includes models with flows to 180 gpm and pressures to 5000 psi, plus a wide variety of controls. For additional information write today for Bulletins 61-81, 61-84 and Catalog 5001C.

HYDRAULIC MOTORS—This fixed-displacement motor is only one of a complete line that includes models for variable horsepower (constant torque) or constant horsepower (variable torque) output characteristics in ratings from fractional to hundreds of hp.

Vickers adjustable-speed hydrostatic drives offer many unique advantages and economies—especially for applications where there are problems of space, weight, fast acceleration, infinite speed or tension control, sudden braking or reversing, hazardous or corrosive surroundings.



VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

Machinery Hydraulics Division

ADMINISTRATIVE AND ENGINEERING CENTER

Department 1430 • Detroit 32, Michigan

Circle 308 on Page 19

HELPFUL LITERATURE

Beryllium-Copper Strip

Brush 190, a mill-heat-treated, beryllium-copper strip which offers tensile strength to 190,000 psi and high formability, is described in new data sheet. Sheet gives mechanical properties for each of six tempers available, and recommended minimum radii for 90-deg bends. Thermal stress relief, forming, and joining procedures are described, with instruction for pickling and plating. 4 pages. Brush Beryllium Co., 5209 Euclid Ave., Cleveland 3, Ohio.

Circle 520 on Page 19

Direct-Recording Camera

New C-12 Camera offers convenience in undistorted viewing and direct recording of oscilloscope traces. Described in Pamphlet A-2060, features include one-hand portability, lift-on mounting, swing-away hinging, and comfortable viewing. Pamphlet illustrates these features, shows typical waveforms recorded by the C-12, and lists accessories. 4 pages. Tektronix Inc., P. O. Box 500, Beaverton, Oreg.

Circle 521 on Page 19

Flexible Metal Hose

Data for selection of the right flexible metal hose for a specific installation are available in Catalog 600. Included is information on how to rate hose working pressures, how to determine correct hose length, and how to install and use hose to insure maximum service life. Also described are standard assemblies—their construction, materials used, fittings, features, applications, and the common media for each. 32 pages. Atlantic Metal Hose Co., 308 Dyckman St., New York 34, N. Y.

Circle 522 on Page 19

Sealing Washer

USL Bartite sealing washer is for use where permanent sealing in a confined area is necessary. New data sheet shows the unit in application, describes the sealing compound, and details the pressure resistance. 1 page. Bartite Products Div., L. J. Barwood Mfg. Co. Inc., Everett 49, Mass.

Circle 523 on Page 19

Standard Switches

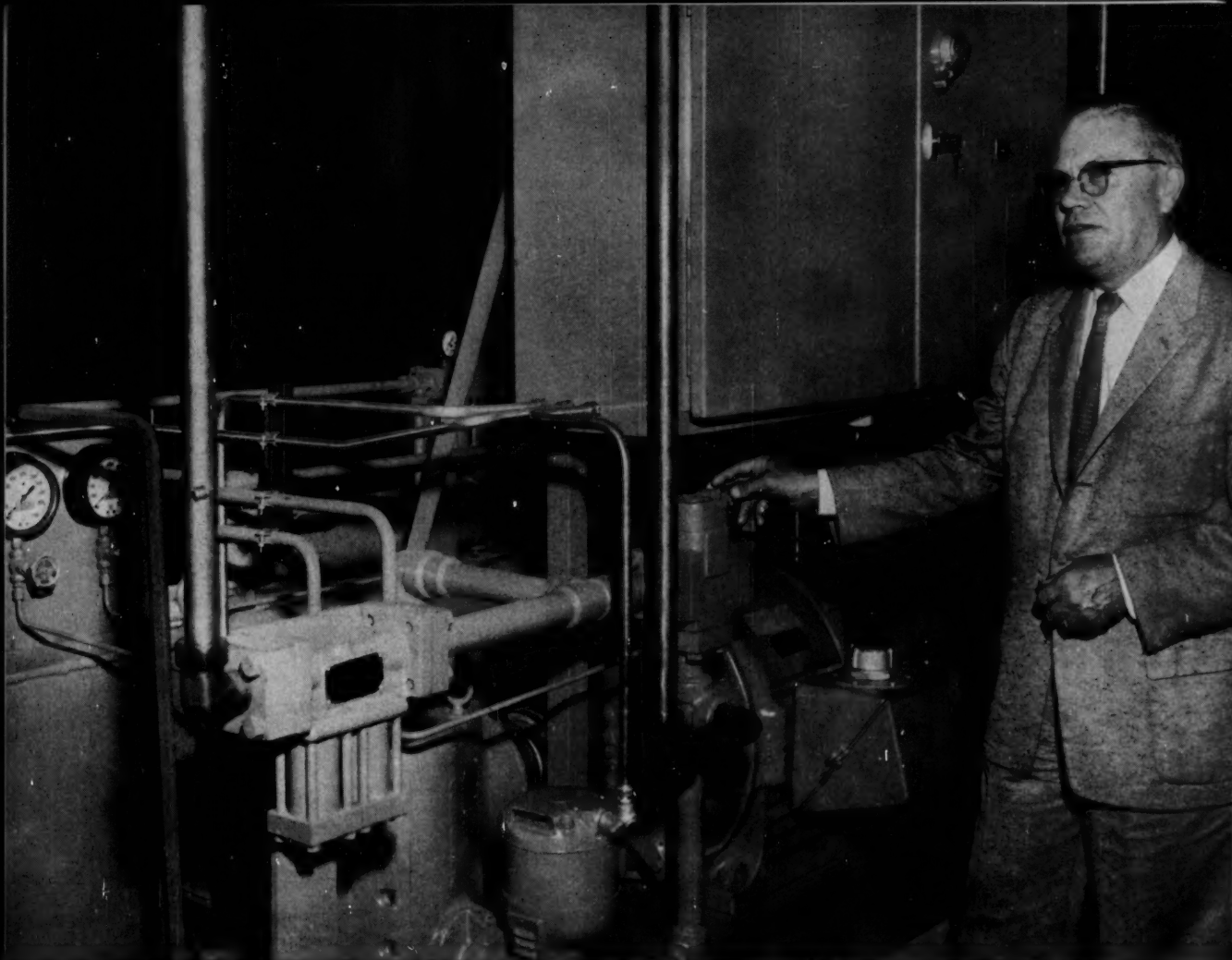
Standard pushbutton, lever, and turn switches are listed in new bulletin. Included are illustrations, ratings, dimensions, and ordering information. 4 pages. Donald P. Mossman Inc., Brewster, N. Y.

Circle 524 on Page 19

Wheels and Casters

Red Tred wheels and casters, with tread of polyurethane elastomer are described in new bulletin. Tread is long lasting and carries heavy weights. Bulletin includes physical properties comparison and wheel and caster specifications. 2 pages. Saginaw Products Corp., 68 Williamson St., Saginaw, Mich.

Circle 525 on Page 19



MELBURN B. HANCOCK, CHIEF ENGINEER, AMF'S UNION MACHINERY DIV., SAYS:

"Hydraulics give us compactness, easy clean-up.."

"... accurate speed control, and freedom from noise and vibration in the operating area. Because the use of adjustable speed hydrostatic transmissions on bread machinery was, in a sense, a pioneering effort, we found it essential and helpful to work closely with Vickers engineers in developing a completely workable system that offered our customers advantages unobtainable elsewhere.

"Our speed control must be accurate since any speed variation may degrade the end product. This speed control is required from about one-half speed to maximum speed of the equipment. Also, the system must be extremely flexible since operating speeds vary from time to time depending on characteristics of the raw material.

"With hydraulics we are able to reduce the overall size of the equipment for the production area where space is at a premium. Combined with other space saving design features, this machine is smaller than would otherwise be possible.

"Last . . . but by no means least in the food industry . . . is the ease with which the machine can be cleaned

(firehoses are usually used to wash down equipment) because hydraulic units are sealed from external moisture, etc. This is a daily operation on breadmaking machinery and is a major advantage to commercial bakeries."

Whether your requirement is for a refinement to existing methods of applying hydraulics or a completely new approach to providing power and control to machinery, Vickers design and application engineers are ready to work with you to effect the most efficient and economical solution. See facing page for more details about components and systems used by Union Machinery Division, American Machine & Foundry Co., and the overall Vickers line.

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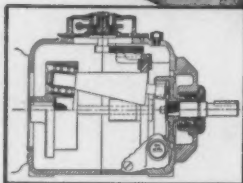
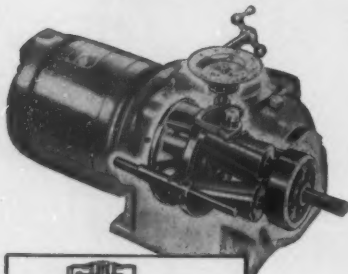
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Three planet roller cones are canted in a carrier to tractionally engage an encircling control ring . . . Pinions on the large ends of the rollers mesh with a ring gear joined to the output shaft . . . Speed is changeable running or stationary . . . Planetary action provides overload protection. The dial permits settings to one part in 4000.

A wide choice of built-in motors, reducers and controls is available in sizes-fractional to 3 HP. Write for full performance data.

GRAHAM EXTRA FEATURES

- Any desired maximum speed to zero, including reverse.
- Straight line extension of a standard motor for true compactness.
- Controls tension, proportion, synchronization, etc., from any type of control signal.

Ask for Graham Catalog 550.

GRAHAM TRANSMISSIONS, INC.
Menomonee Falls, Wisconsin

Circle 310 on Page 19

HELPFUL LITERATURE

One-Piece Pulleys

One-piece steel Curve Crown pulleys, featuring spun-end construction, are covered in Bulletin 1160. All end-plate weldments have been eliminated. Brochure also describes the Squeeze Lock hub which exerts equal locking forces in two directions, to both the shaft and pulley end plates. Other data include a pulley load-rating chart, dimensions and weights, and charts which show a comparison of belt training effects for various types of pulleys. 8 pages. Stephens-Adamson Mfg. Co., Aurora, Ill.

Circle 526 on Page 19

Cradle-Mounted Pumps

Cradle-mounted, centrifugal pumps meet the requirements of the chemical industries for general chemical and process service, and can be used on almost any service requiring a pump to handle both corrosive and noncorrosive liquids. Described in Form 70288, three models cover sizes from 1/4 through 50 hp. Data include dimensions, special features, and applications. 4 pages. Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.

Circle 527 on Page 19

Coated Strip Steels

New brochure discusses the industrial application of coated strip steel. Designed to help in the selection of the proper coated steel, booklet covers Galvanite, Bright Zinc, special alloy coat, electro-galvanized, and painted and printed steel. It details size ranges, forming, welding, soldering, cleaning, chemical treatment, temper classifications, and Preece tests. 12 pages. Sharon Steel Corp., Sharon, Pa.

Circle 528 on Page 19

Waveguide Flanges

Catalog FA-61-1 provides full data on both single and dual waveguide-flange types. Included are line drawings and dimensional tables, and cross-reference index. 16 pages. Microwave Development Laboratories Inc., 15 Strathmore Rd., Natick Industrial Center, Natick, Mass.

Circle 529 on Page 19

Leakproof Pumps

Bulletin 1100-1 describes complete line of seamless, leakproof pumps. It covers design, operation, and selection of the units, points out features of the various types, and includes a specification chart. 4 pages. Chempump Div., Fostoria Corp., Huntingdon Valley, Pa.

Circle 530 on Page 19

Variable-Speed Drives

Servospeed drives in many sizes and types are covered in new bulletin. Complete units are pictured and described, and components are also shown in dimensional drawings. Full specifications are included. 16 pages. Electro Devices Inc., 4-6 Godwin Ave., Paterson 1, N. J.

Circle 531 on Page 19

Thinking
small



LOW COST

***MINA** bearings
stimulate

industrial and commercial
miniaturization programs

eliminate

both economic and technical
barriers to using miniature
ball bearings in a wide
variety of products.

GET ALL THE FACTS

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***MINA** Bearing is the
trade name for *low cost*
ABEC-3 miniature ball
bearings manufactured in U.S.A. by

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BEARING
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RETNE, NEW HAMPSHIRE, U.S.A.

Circle 311 on Page 19

Aeroquip Introduces New Low-Cost Reusable Fitting for High Pressure Hose Lines



How IRON MIKE Fitting Grips Hose

NIPPLE

Designed to fit into hose without cutting inner tube. Available in 10 end fitting styles.

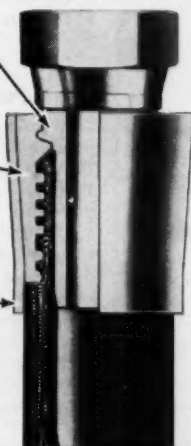
SEGMENTS

Grip hose reinforcement securely, mate with nipple assembly for correct positioning.

SOCKET

Forced over segments during assembly to form a rugged compression fitting that won't blow off.

PATENT APPLIED FOR



Meet IRON MIKE, a rugged new hose fitting that provides all the field service advantages and replacement economy of reusable fittings—at rock-bottom prices. Hose assemblies made with IRON MIKE Reusable Fittings compare in cost with assemblies made with non-reusable fittings. Design is so simple that foolproof assemblies can be made by factory or service personnel in minutes.

IRON MIKE Fittings have been field tested for more than a year to assure traditional Aeroquip performance and dependability. Used with Aeroquip 1509 Multiple Wire Braid Hose, they are recommended for all industrial high pressure hydraulic applications up to 2250 psi. as well as pneumatic, fuel and lubrication systems. IRON MIKE Fittings are available in ten standard end styles for hose sizes from 3/4" to 2" I.D.

Mail coupon below for new Aeroquip Bulletin No. 651.



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ROPER PUMPS

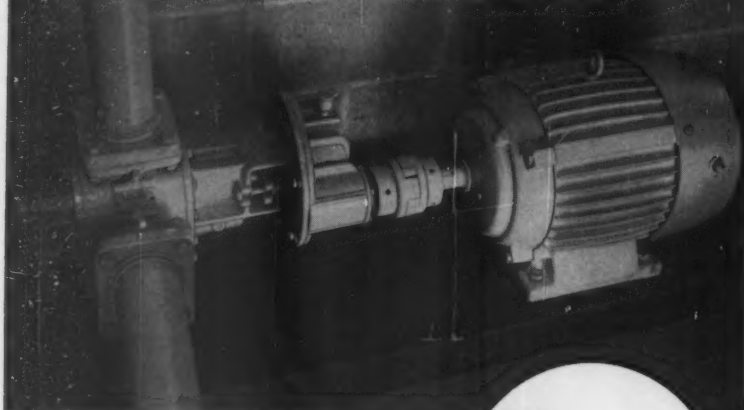
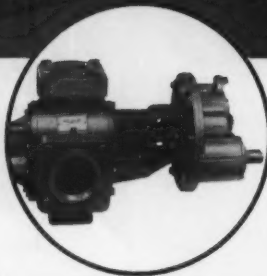


Photo courtesy Custom Cannery, Atlanta

SERIES 3600 MAHBRV #4

**supply high
viscosity liquid
sugar in canned
soft drink operations**



• **OUTPUT CAPACITY: 40-300 GPM** • **PRESSURES TO 100 PSI**

The Potter & Rayfield liquid sugar system installed for Custom Cannery, Inc., producers of canned soft drinks, uses Roper Series 3600 MAHBRV #4 as the pumping component. Specification of a Roper unit for the system was made to handle the 10,000 SSU viscosity of the 50% inverted liquid sugar at 60°F, and lower, temperatures. The installation requires consistent output at slow pump speeds. Batch-type production means intermittent pump service, but the unit still handles some 1500-3000 gallons per day. In addition, unloading, transfer to storage, and movement of syrup to mixing vats are handled by the Roper pump, which is connected to a 1800 rpm, 7½ hp motor. Standard, specially modified, and custom Roper units serve original equipment in a wide range of industries—marine, process, chemical and petroleum. A Roper can serve the needs of your equipment also.

Balanced Construction—Reliable Production

- **Axial Hydraulic Balance** of the gears provides vibration-free operation, smooth, pulsation-free output.
- **Gear Construction** includes special machining for tooth forms to insure correct meshing and efficient displacement.
- **Induction Hardening** of steel shaft at bearing and packing surfaces means longer, maintenance-free service.
- **Four High-Lead Bronze** or chrome-iron bearings give balanced support and maintain proper alignment for the helical-type pumping gears. Sleeve bearings are heavy-duty bronze.

**For information about your specific pump needs
contact your nearest Roper dealer**

Send for new 16-page Series 3600 catalog

**ROPER
HYDRAULICS, INC.**

**Dependable pumps
since 1857
COMMERCE, GEORGIA**

HELPFUL LITERATURE

V-Band Couplings

Bulletin WB-1, "How, When and Why to use a V-Band Coupling," explains how the simplified fastening of the coupling improves functional design and product appearance, decreases assembly time, and cuts manufacturing costs. Booklet also illustrates a few of many available coupling and flange configurations, explains the sealing principle, and shows typical V-Band applications. 8 pages. Marman Div., Aeroquip Corp., 11214 Exposition Blvd., Los Angeles, Calif.

Circle 532 on Page 19

Copper-Clad Laminates

Seven grades or types of Micarta copper-clad laminates for printed circuits can be compared in physical and electrical properties in Brochure B8215. Recommended applications are included for each laminate to guide in selection. Included in five paper-base phenolic grades are two new grades having high fire resistance and one for applications that are electrically critical. 8 pages. Micarta Div., Westinghouse Electric Corp., Hampton, S. C.

Circle 533 on Page 19

Magnetic Counter

Series 1591 high-speed magnetic counter provides remote indication of equipment operation. Included is a list of typical applications where the electrically actuated unit is useful. Timing of contact co-ordinates is discussed, and standard specifications are given in both tabular form and engineering drawings. Photograph illustrates the external appearance of the unit. 4 pages. Veeder-Root Inc., 70 Sargeant St., Hartford 2, Conn.

Circle 534 on Page 19

Small Pumps

Featuring capacities to 3000 gph and offering pressures to 350 psig, small Type PRA pumps are available in 16 sizes. Each is detailed in dimension drawings, parts lists, and a rating chart in Bulletin 150.6. Bulletin also covers the simplified function of the rotor-stator elements in developing uniform flow, positive displacement, low internal velocity, and the ability to transport relatively large particles in suspension without damage to the pump or materials. 4 pages. Moyno Pump Div., Robbins & Myers Inc., Springfield, Ohio.

Circle 535 on Page 19

Asbestos Parts

Packings, gaskets, textiles, and friction materials of interest to aviation, missile, and spacecraft industries are described in Catalog PK-162A. Emphasis is put on custom-made parts for severe service applications. Booklet includes considerable tabular data and illustrations concerned with the products and their applications. 28 pages. Johns-Manville Co., 22 E. 40th St., New York 16, N. Y.

Circle 536 on Page 19

Strain Gages

Semiconductor strain gages are small units which produce a high output, high frequency, and high resolution. Bulletin K-102 discusses Series DB strain gages, fully explaining and showing how they operate. Table of gage characteristics and dimensions is incorporated. 4 pages. Kulite-Bytrex Corp., 50 Hunt St., Newton 58, Mass.

Circle 537 on Page 19

Lubrication Equipment

Featured in Catalog 82 is complete line of lubricant application equipment, with descriptions of fully automatic, semiautomatic, and manual methods of operation. High and low-pressure lubricant injectors, timing and alarm controls, and filler pumps are described, along with installation accessories such as tees, hose, flexible feed lines, and coupling studs. 32 pages. Lincoln Engineering Co., 4010 Goodfellow Blvd., St. Louis 20, Mo.

Circle 538 on Page 19

Vacuum Metallizing

"New Developments in Vacuum Metallizing" describes metallizing coatings systems which can be applied by spraying, dipping, or flow coating to thermoplastics, thermosetting plastics, metals, and glass. Base coats applied before metallizing and top coats and back-up coats for use after metallizing are detailed. Thinning information and system properties are also given. Several new coatings systems for use on bottle caps and automotive arm rests and knobs are also described. Systems guide is in chart form which can be mounted for ready reference. 4 pages. Bee Chemical Co., 2700 E. 170th St., Lansing, Ill.

Circle 539 on Page 19

Pointer-Indicator

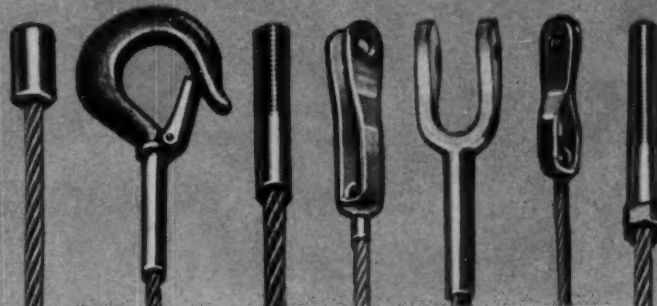
Type 110 SR-4 pointer-indicator and indicating controller for strain-gage transducer systems is discussed in Bulletin 4411. Bulletin provides a summary of features, applications, accuracy, and controls; a two-page graphic selection chart; sample application system sketches; specifications table; dimensions and connection details. 6 pages. Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass.

Circle 540 on Page 19

Vulcanized Fiber

New folder provides data on vulcanized-fiber sheets, rods, and tubes. Included is information on various grades, storage, specific applications, advantages, and physical, chemical, and electrical properties. Chart compares the fiber with other materials in insulating properties, aging, and effects of oil, water, heat, and acids. 6 pages. Wilmington Fibre Specialty Co., New Castle, Del.

Circle 541 on Page 19



Why bother with "home-made" wire rope assemblies?..

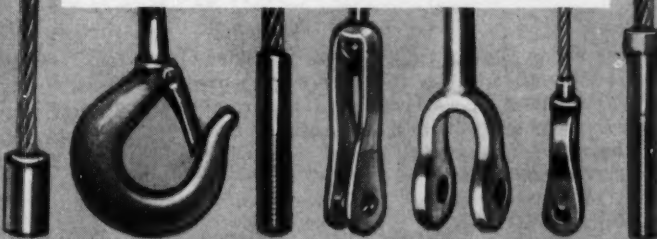
Cut your production costs with TRU-LOC ASSEMBLIES

If you are using "home-made" wire rope assemblies, consider the advantages of precision-built TRU-LOC Assemblies. With them you can be sure of consistent uniformity in length, strength, flexibility and accuracy of fittings. Swaged by the Tru-Loc process to preformed rope of $\frac{1}{8}$ " to 2" diameter, fittings develop a strength equal to that of the rope itself.

TRU-LOC Assemblies come to you complete, ready to use. They simplify installation and often cut production costs. They are neat, versatile and can be made with a wide choice of attachments to your specifications. Their per unit price may be lower than the cost of "home-made" assemblies. You get complete assemblies at a known price and eliminate variables in cost and quality. Send us a sketch of your requirements, indicating quantity, and we'll furnish a prompt quotation.

FREE REFERENCE CATALOG

This 28-page reference catalog contains photographs, engineering drawings and dimensions that provide answers to many design problems. To receive your copy, write us at Wilkes-Barre, Pennsylvania.



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ACCO



American Chain & Cable Company, Inc.

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"The Gravity Kid" shows how

CONTOUR-WELDED STAINLESS TUBING DEFIES CORROSIVE ATTACKS

It's smoother inside than any other tubing—welded or seamless—because the patented* Contour-welding process virtually eliminates the weld bead. And this smoother surface ensures greater resistance to corrosion—simply because there are fewer focal points for corrosive attack.

You see, in conventionally welded tubing, gravity pulls the molten metal down into the tubing. This forms a bead that is difficult to remove by cold working. And cold working can lead to undercuts that become focal areas for corrosive attack.

Contour-welded tubing, however, is welded at the bot-



tom. Gravity still pulls the molten metal down. But now the weld area corresponds to the contour of the tube. There's virtually no weld bulge on the inside surface. And even on the O.D., the weld seam closely conforms to the tubing contour.

Contour-welded tubing is smoother, too, than seamless. That's because it's formed from uniformly rolled strip steel, whereas seamless is extruded or pierced.

But get full details on this corrosion-resistant tubing. Send for our free 48-page manual on Contour-welded tubing in sizes from 1/8" to 40" O.D.—in stainless and high alloy steels, titanium, zirconium, zircalloy and Hastelloy.*

*Trademark Haynes Steelite Co.

TRENTWELD® Stainless and High Alloy Tubing

Trent Tube Company, a Subsidiary of Crucible Steel Company of America. General Offices and Mills: East Troy, Wisc.; Fullerton, Calif.

Motor-Operated Valves

Two and three-way, motor-operated valves are available for use in fan-coil units. Bulletin 210 covers the Series 436A Motortrol valve units, how they operate, and typical installations. Exploded views and dimensional drawings are also included. 6 pages. Erie Mfg. Co., 4000 S. 13th St., Milwaukee 21, Wis.

Circle 542 on Page 19

Machine Mounts

Catalog 4011 describes Wedgmount, Jacmount, and Air-Loc machinery mounting pads. Each type of mount is illustrated, and sizes and capacities available are listed. Also included are tests which show the physical properties of the mounting material. 4 pages. Clark-Cutler-McDermott Co., Franklin, Mass.

Circle 543 on Page 19

Electronic Cooling Fan

Bulletin J-621 describes Series 60 Axivane fan, designed for high performance in electronic cooling applications. Bulletin provides detailed performance data, application hints, and a complete sound-level frequency analysis of each of the ten sizes. 8 pages. Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa.

Circle 544 on Page 19

Digital Transducers

Digital transducers and subminiature pressure instruments are furnished in self-contained solid-state packages. Set of six technical bulletins includes features, characteristics, and outline drawings of the units. 12 pages. Electronics Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 545 on Page 19

Roller-Chain Applications

Design folder for roller-chain applications includes 19 complete mechanical drawings showing new ideas of how roller chain can be used. Applications shown in the blueprints include roller chain used as a slat conveyor, reciprocating drive, feed-roll drive, chain-roller bearing, external gears, internal gears, flexible-shaft coupling, rack and pinion table feed, lever actuator, rod conveyor, and others. About 20 pages. Write on company letterhead to Atlas Chain & Mfg. Co., Dept. DK, West Pittston, Pa.

Rolling Diaphragms

Approximately 1200 standard sizes of rolling diaphragms, in bore sizes from 0.31 to 12.17 in., for strokes from 0.020 to 14.98 in., with details of operating characteristics for each are listed in Bulletin 50A. Tables show diaphragm class, cylinder bore, piston diameter, effective pressure area, height, and side-wall thickness. Drawings identify five standard classes according to mounting method. 8 pages. Write on company letterhead to Bellofram Corp., Blanchard Road, Burlington, Mass.



A BASIC CONTROL IDEA

as simple as

1 + 2 = 3



DESIGN YOUR
NEXT MACHINE
OR PROCESS
CONTROL CIRCUIT
THIS EASY WAY



Start with **THE BULLETIN 780 STEP SWITCH**
FOR STEP-BY-STEP
SEQUENCE **CONTROL**

- 1 INPUT SIGNALS**

Closure of a control device, actuated upon completion of an operation, advances control to next position.

+

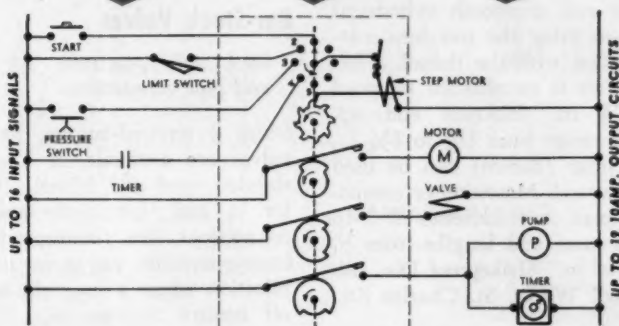
2 BULLETIN 780 STEP SWITCH

Circuits are opened or closed at each position or step according to preselected cam action.

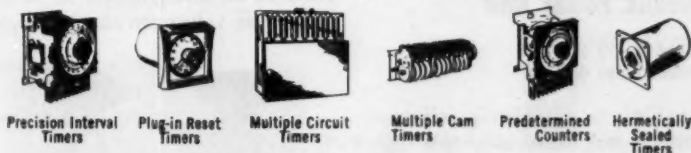
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3 PROGRAMMED SEQUENCE CONTROL

Loads are interlocked thru step switch cams without complicated relay circuitry.



Write for Bulletin 780 or call your local Representative. He's listed in Sweet's Product Design File, Section 7d/EA, or in Thomas Register.



MANUFACTURERS OF THE MOST COMPLETE LINE OF INDUSTRIAL TIME-COUNT CONTROLS AVAILABLE



EAGLE SIGNAL COMPANY • Moline, Illinois
INDUSTRIAL DIVISION

DIVISION OF THE GAMEWELL COMPANY, AN E. W. BLISS COMPANY SUBSIDIARY

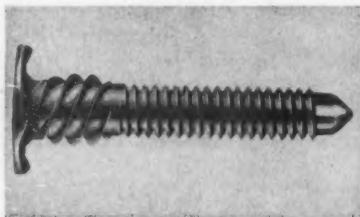
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Mounting Screws

eliminate the need
for countersinking

New mounting screws are available in two standard head designs: Wafer and flat head. They eliminate the need for countersinking to obtain flush mountings. These parts have multiple-thread, left-hand retaining sections and torque-increasing nibs under the head to prevent stripping the panel and to eliminate the need for retaining nuts. New point consists of a lead-



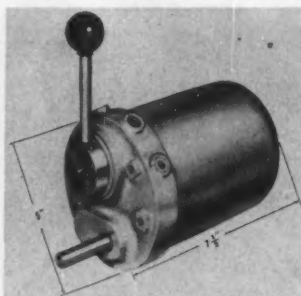
in cone and a smooth cylindrical section to bring the nut into mating position with the thread. Flat-head screw is suitable for plywood from $\frac{3}{8}$ in. thickness and up. Lengths range from $1\frac{1}{4}$ to $1\frac{3}{4}$ in. Wafer head (shown) can be used with plywood, Masonite, or composition board in thicknesses of $\frac{3}{16}$ in. and more and lengths from $\frac{3}{4}$ to $1\frac{3}{16}$ in. Shakeproof Div. Illinois Tool Works, St. Charles Rd., Elgin, Ill.

Circle 546 on Page 19

Hydraulic Power Unit

delivers $2\frac{1}{2}$ gpm at
pressures to 400 psi

Hydro-Unit, a completely self-contained control, features a new hydraulic-gear pump with fingertip control, system relief valve, four-way control valve, three-way control valve, and reservoir tank. Pump delivers up to $2\frac{1}{2}$ gpm at pressures



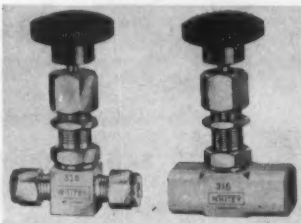
to 400 psi, with shaft speeds to 1800 rpm. Pump is built for long, continuous, trouble-free operation. Self-contained reservoir tank has a capacity of 0.4 gal. Unit is 5 in. ID, $10\frac{3}{8}$ in. long. It requires less than 160 cu in. of space when installed and weighs less than 10 lb (dry). Less than $\frac{1}{2}$ hp is required to operate the Hydro-Unit at maximum pressure. Hein-Werner Corp., Waukesha, Wis.

Circle 547 on Page 19

Bar-Stock Valves

for $\frac{1}{8}$ and $\frac{1}{4}$ -in. tube
and pipe connections

Series 2 screwed-bonnet, bar-stock valves are available in Type 316 stainless steel and Monel. Valves, for $\frac{1}{8}$ and $\frac{1}{4}$ -in. tube and pipe connections, are recommended for instrumentation use or for any application where a leaktight on-and-off control is essential. With a choice of Swagelok tube-fitting connections, or female pipe-thread connections on straight and angle-pattern styles, valves can also be ordered



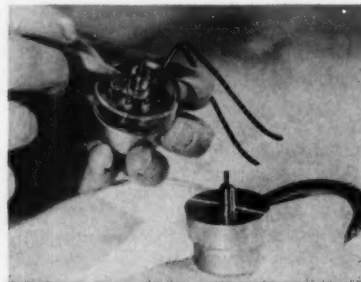
with Swagelok inlets, female pipe outlets, or female-pipe inlets to Swagelok outlets. Whitey Research Tool Co., 5525 Marshall St., Oakland 8, Calif.

Circle 548 on Page 19

Synchronous Timer Motor

is oil filled for
silent operation

New synchronous timer motor has all moving parts sealed in oil to achieve noiseless continuous operation. A spring-loaded packing gland prevents the oil from working out of the housing when the motor is operating. Neoprene O-ring held under constant pressure by a spring seals in the oil. Applications include industrial automation control systems, computers, office equipment, home appliances, and military control devices. OD



of the motor is $1\frac{11}{16}$ in. Lake City Inc., 110 W. Woodstock, Crystal Lake, Ill.

Circle 549 on Page 19

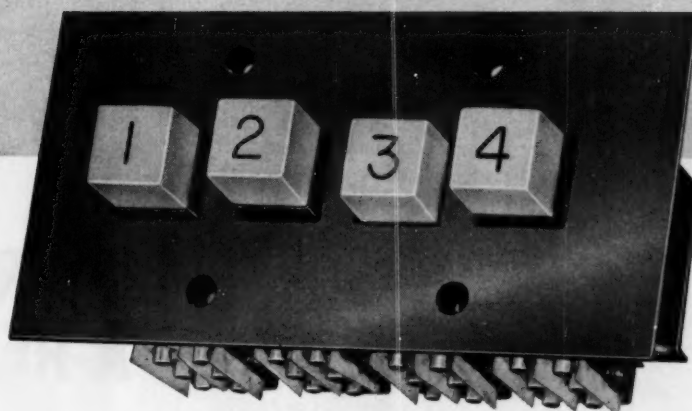
Semiprecision Bearings

handle radial and
thrust loads

Semiprecision bearings feature press-formed construction throughout. All races are carburized and hardened, and all balls are heat treated and accurately ground. Designed to handle both radial and thrust loads,

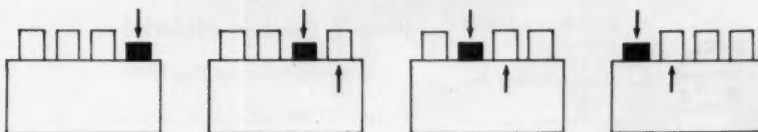
CHEAT-PROOF

4-STATION INTERLOCK LIGHTED PUSHBUTTON SWITCH



MODEL WC-1730
actual size

*Always One Station Committed.
Can Not Commit 2 Stations
Simultaneously.
Front Panel Lamp Replacement.*



This new Control Switch concept in multi-station interlocking switches features a unique "CHEAT-PROOF" design. One station is **always** committed. It is impossible to tease the system into an "all stations up" position. Actuating any of the four lighted pushbuttons causes the previously depressed button to return to normal at the exact point the system is committed to an alternate station. A lockout system makes it impossible to commit two stations simultaneously.

The Pushbuttons are individually illuminated with standard MS 25237 type lamps which are easily replaced from the front. Buttons are available in six colors and can be engraved.

The new Control Switch Interlock has been designed to permit various other station combinations. All units are engineered to withstand unusually high shock and vibration conditions.

CHARACTERISTICS

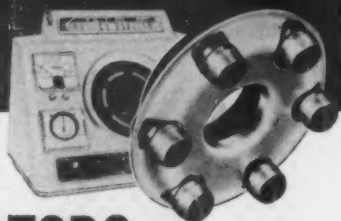
Station Circuit	D.P.D.T.
Electrical Ratings	5 amps @ 125-250 VAC
	5 amps Res. @ 30 VDC
	2.5 amps Ind. @ 30 VDC
	Switches per MS 25085-1
Lamps (not furnished)	MS 25237 Type
Weight	9 oz. max.
Size	panel surface 3 $\frac{3}{4}$ " x 2"
	depth behind panel 1 $\frac{1}{8}$ "

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION

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Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading electronic parts Distributors.

another NEW IDEA



TORQ SPEED DETECTOR CONTROL

Patents & Patents Pending

In another of many new-idea applications, a compact TORQ speed detector switches a speed scale for continuous, direct reading from the 0-1,000 to the 0-4,000 band, in an automobile distributor testing instrument. At the same time, the TORQ device automatically controls color-coded lamps to designate the scale in operation. The results are fool-proof direct reading of speed, simpler instrument operation and increased versatility.

TORQ speed detecting/control devices are snap acting, centrifugal switches. They actuate on speed alone, are virtually frictionless in operation, are built to specification tolerances at speeds from 0 to 15,000 rpm and are rated up to 1.5 million cycles of uniform operation.



● **DIESEL ENGINES** are practically run by a TORQ switch . . . cuts out cranking motors, controls cooling circuit, provides differing fuel requirements, signals full speed.



● **ELECTRONIC EQUIPMENT** is protected against overheating with a TORQ switch to cut out circuit in event of cooler blower failure.



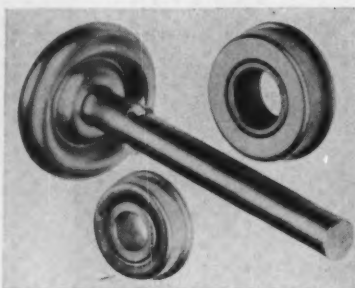
● **CONVEYORS** are turned off automatically with TORQ switch if, for any reason, they fall below proper operating speed.

If your equipment employs a rotating shaft, you can use a TORQ switch.



Circle 318 on Page 19

NEW PARTS AND MATERIALS



bearings are easy to install, and can be supplied with or without flanges. Kendale Washer & Stamping Co., 5217 Sweeney Ave., Cleveland 27, Ohio.

Circle 550 on Page 19

Epoxy Adhesive

cures in 1 minute
at room temperature

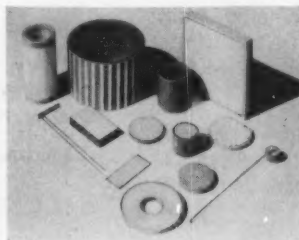
Minit-Cure is a rapid-curing, formulated epoxy adhesive which cures in 60 sec at room temperature and can be accelerated to 45 sec with use of infrared heat. Resin-hardener adhesive system is suitable for automatic meter-mixing-dispensing units in rapid production line work. Possible applications include bonding metal to metal, plastic to metal, or plastic to plastic. Allaco Products, 238 Main St., Cambridge 42, Mass.

Circle 551 on Page 19

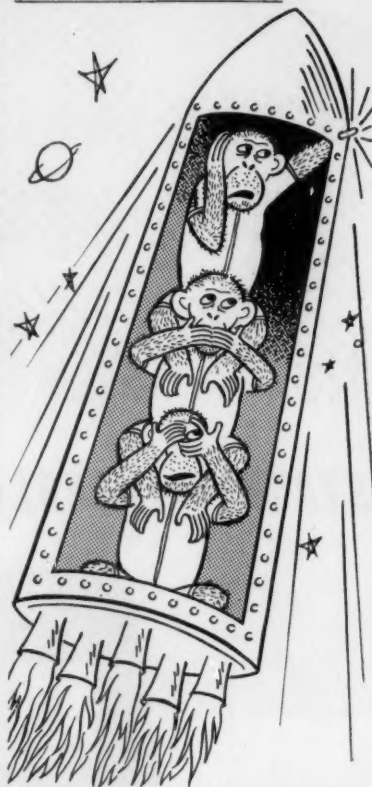
Piezoid Ceramic Material

for transducer applications

Composition KE-14 is available in a variety of shapes. Discs, cylinders, tubes, plates, and blocks can be supplied, as well as unsymmetrical shapes. Material has a stable dielectric constant from 55 to 300 C, making it useful for a wide range of transducer applications. Transducer elements can be supplied with electrodes covering the entire surface of the element or limited to any designated area. Ele-



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HEXSEALS are modular external seals. They fit onto switches, potentiometers, circuit breakers and lighted push-buttons.

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APM PRODUCTS MEET
ALL APPLICABLE MIL SPECS.

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A.P.M. Corp.

41 Honeck Street, Englewood, N. J.
LOWell 9-5700

Circle 319 on Page 19

Along with outer space . . .



the T-J *Spacemaker*
is still making

BIG NEWS

The T-J Spacemaker cylinder line is not now, nor ever has been, a probe into outer space. It is offered as a practically designed, research engineered and time tested product. Its Spacemaker feature (no tie-rods) and rugged construction gives greater strength, saves space and reduces costs in all power

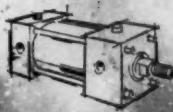
drive applications. The Spacemaker is available in a complete range of bore sizes and strokes, air or hydraulic, and contains many plus features and extras as STANDARD . . . NO EXTRA COST! Write Tomkins-Johnson, 2425 W. Michigan Ave., Jackson, Mich. for Bulletin #155-4 and for full particulars, today.



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CLINCHERS



CYLINDERS

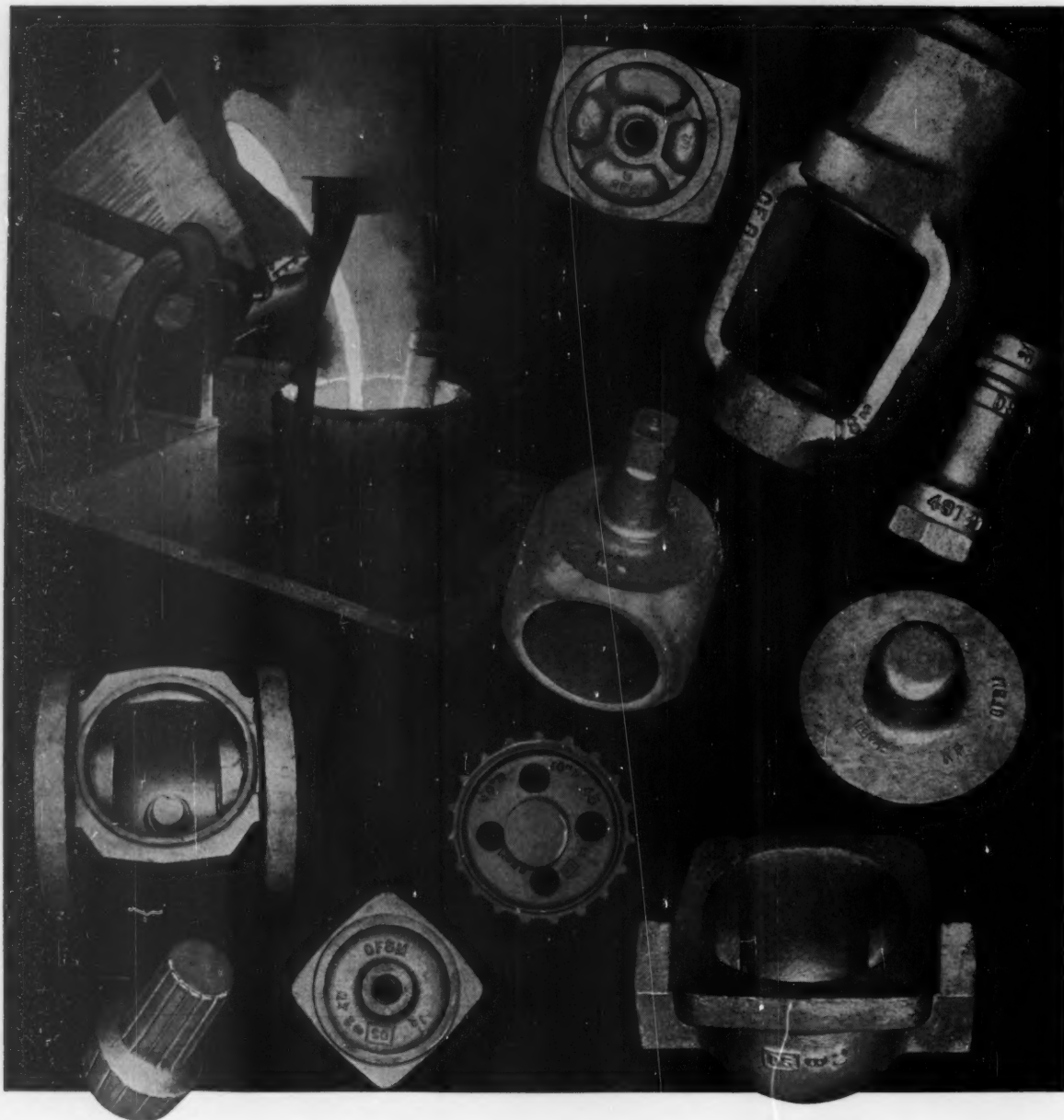


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TOMKINS-JOHNSON

JACKSON, MICHIGAN



NAME YOUR **STAINLESS** SHAPE!

The design and manufacture of quality stainless steel castings is a specialized job . . . *and Dodge specializes in it!*

There is practically no limit to the variety of shapes we can turn out to meet your simple or intricate specifications precisely . . . economically.

Perhaps one or more **DS** castings shown here will help spark an idea of how Dodge can

be of assistance for *your* stainless steel casting needs. A blueprint or sketch with operational details will bring complete information, without obligation.

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DS

**DODGE
PRODUCTS**

THE MOST IMPORTANT ALLOY IN A **STAINLESS** STEEL CASTING IS QUALITY

ments can be supplied with leads attached. Centralab Div., Globe-Union Inc., 900A E. Keefe Ave., Milwaukee 1, Wis.

Circle 552 on Page 19

Plain Journal Bushings

are capable of dynamic loads to 25,000 psi

Self-lubricating, plain journal bushings in bore sizes from $\frac{1}{4}$ to 3 in. are capable of dynamic loads to 25,000 psi and static yield loads to 50,000 psi at low rotational speed. Stainless steel housings are em-



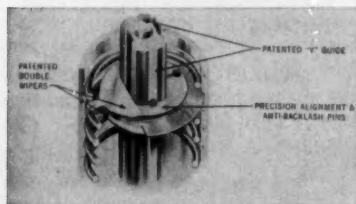
ployed, and bushings have a plastic alloy Dyflon insert. Southwest Products Co., 1705 S. Mountain Ave., Monrovia, Calif.

Circle 553 on Page 19

Rotary Potentiometer

incorporates a double-wiper system

Series 341 rotary-type potentiometer is suitable for application in avionics and other analog-computing systems where size, function, and reliability are prime requisites for operational efficiency. Series is also available with a clutch for servo installation. V-guide is combined with precision alignment and antibacklash pins to provide a double-wiper system which doubles resolution and eliminates intermittents caused by shock and vibration. Series is available in resistance ranges from 1-600 K, can carry 2.5 w in still air at 40 C, and operates from -55 to +140 C.



July 20, 1961

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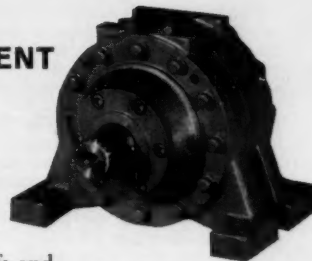
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HydRoAc's high quality means long life and low internal leakage... Expect efficiencies to 95% and over with these compact and powerful high-pressure hydraulic rotary actuators... Unlimited commercial applications range from turret lathes to farm machinery... Instantaneous torque in both directions... Rated operating pressure 3000 p.s.i.... Foot or end mounted... Designing a new product or re-designing an old one... get the Houdaille HydRoAc story first!



... Specialists in rotary
type hydraulic equipment

Houdaille Industries, Inc.

Buffalo Hydraulics Division • Dept. B • 537 E. Delavan Ave., Buffalo 11, N. Y.

Circle 322 on Page 19

201



SETTING THE PACE

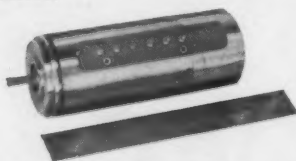
by Eston Fox, Sales Manager, Pace Controls Corp.

New Key Component for Servo Control

Modern high precision servomechanism control systems are now benefiting from a revolutionary new concept... the DIGITORK Incremental Motor. Unique among "stepping" motors, this *true* motor provides high speed, torque, accuracy, and repeatability while eliminating many design problems encountered in systems using conventional servos. Available with torques up to 20 in.-lbs. (higher with "specials") and controlled stepping rates up to 3000 per second, it's the *logical* motor for use with today's advanced digital techniques.

Inherent High Accuracy

The DIGITORK motor is a *true* digital motor. It responds with a discrete increment of motion to each signal pulse. Speed of motion is controlled by the rate of signal input. An increment can be made any integer or fraction, with the whole motion equal to the sum of the equal increments. Any motor error zeroes out at every third step. Thus the maximum error of the whole motion can be no greater than the error inherent in one increment. This high precision design also eliminates the hunting and instability common with conventional servos.



Model M118 DIGITORK Motor provides 0-2800 steps per second and 2 oz.-ins. torque.

Simplicity and Economy

The DIGITORK motor as a control component, with today's digital trend in circuit design, is far more compatible than conventional servos. Using it, performance of other components and sub-systems can be more easily predicted. The DIGITORK motor usually eliminates the need for such elements as highly complex amplifiers, tachometers, transducers, and analog-to-digital converters, thus cutting system costs considerably.

"Servo" vs Digitork

Let's consider a hypothetical problem; control of two linear motions... 1 inch and 100 inches respectively. Handled by a conventional servo, total length in each case is treated as an entirety from one bit of information. Any error in the bit will be reflected in the accuracy of

the total motion. Since the servo utilizes feedback for positioning, this introduces errors inherent in the circuit and tolerances in the overall length, including those produced by overshoot and backlash. And since the total percentage error is the same for both controlled motions, actual error for the 100-inch motion may well be greater than the whole 1-inch motion! This error can be reduced by the addition of more components, circuitry and cost, but — this is not necessary when using DIGITORK — as described below.

Using a DIGITORK motor for the same two motions, control of total length motion is achieved through a finite number of equal incremental motions. Accuracy of the whole depends on that of just *one* increment, regardless of the total number. Thus, we can use a DIGITORK motor with each step equal to .001" linear motion... rated error for one step being $\pm .0001$ ". So, 1000 signal pulses will advance it 1000 steps (1 inch) and 100,000 pulses will advance it 100,000 steps (100 inches). Total error in each case: $\pm .0001$ inches.

Digitork Motor Applications

The DIGITORK motor is presently in use in systems requiring accuracies of .000020" linear and .002 degrees rotational. It can be used to precisely coordinate and control motion between two or more axes. Size of resultant motion can be changed by appropriate gearing.



Put this accuracy and versatility to work on your control problems. Write for Engineering Bulletins today.

DIGITORK is truly... Setting The Pace!



Needham Heights 94, Massachusetts • Hillcrest 4-8844

NEW PARTS AND MATERIALS

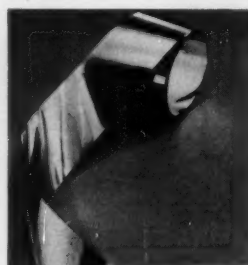
Over-all size of the unit is $\frac{1}{2}$ in. diam and 1 in. long. **Potentiometer Div., Daystrom Inc., Archbald, Pa.**

Circle 554 on Page 19

Stainless-Steel Strip

has highly reflective finish

Unibrite stainless-steel strip has a highly reflective finish. Unibrite process imparts extra brightness and maximum corrosion resistance by buffing after processing. Consistency of finish, color, shading, and reflectivity are maintained on both sides of the strip, and uniformity



is maintained from coil to coil. **Universal-Cyclops Steel Corp., Bridgeville, Pa.**

Circle 555 on Page 19

Printed-Wiring Boards

are completely etched

Preferred Circuits printed-wiring boards incorporate circuits from the "Navy Handbook of Preferred Circuits" in a modular printed-wiring design that meets all military specifications. Boards are completely etched, requiring only drilling and inserting of components for finished assembly. Tube and transistor circuits are available. **Advanced Design Inc., 914 Lullaby Lane South, Vienna, Va.**

Circle 556 on Page 19

Fractional-Horsepower Motors

have horsepower from 1/150 to 1/3

Line of 14 different fractional-horsepower, frame size 11, ac motors is available in four types. Operation is on 60 or 400 cycle, single, double, or triple phase, 115 or 120/208 v. Horsepowers developed

OPENING NEW HORIZONS

... in economical power application

98% PLUS OPERATING EFFICIENCY
MORE POWER PER CYLINDER DOLLAR
PROVEN LEAKPROOF OPERATION
GREATEST SELECTION EVER OFFERED
SAFE UNDER SEVERE LOADS
SAFE WITH ALL KNOWN HYDRAULIC FLUIDS
SAFE UNDER TEMPERATURE EXTREMES
DAMAGE-PROOF PISTON RODS

Miller HYDRAULIC CYLINDERS



Flick-Reedy... Winner of "Plant of the Year" Award and "Silver Anvil" Public Relations Award



MORE SAVINGS!

Our ultra-modern, new "Plant of the Year" with its special facilities and operating economies enable us to offer an extra 10% price savings on our big "stock" selection of:

Model "H" (Hyd.) Cylinders, 1½" through 8" bores;
Model "J" (Hyd.) Cylinders, 1½" through 14" bores;
Model "A" (Air) Cylinders, 1½" through 14" bores.
Strokes up to 36", cushioned and non-cushioned.

Full Details On Request

Miller Hydraulic Cylinders make impossible applications look easy. With Teflon Seals, Case-Hardened Rods (50-54 Rockwell C), Patented "Shel" Tubing End Seals, and other exclusive *standard* features, these cylinders are practically damage-proof, are ultra-dependable under pressure and temperature extremes, and provide leakproof sealing with ALL hydraulic fluids. Built to *exceed* J. I. C. Specifications, these cylinders are achieving new highs in production and operating economies in thousands of plants. Two great lines: Power-Packed Model H for 3000-5000 psi and Job-Rated Model J for 500-2500 psi. All bores, strokes and mounting styles. Big "Stock" selection for immediate shipment at substantial savings.

Write for literature.



R

MILLER FLUID POWER

DIVISION OF TUCKER-ARMY CORPORATION

7N016 YORK ROAD, BENSENVILLE, ILLINOIS

WE AND WE ASSOCIATED COMPANIES - ACCUMULATORS
COUNTER-BALANCE CYLINDERS - BOOSTERS

Circle 324 on Page 19

LOWELL REVERSIBLE RATCHET WRENCHES

designed to solve your problems

Speed of operation, simplicity of ratchet control, great strength . . . these are three big reasons why machinery designers write Lowell Reversible Ratchet Wrenches into their specifications.

- Remote or conventional reversing control.
- Handles any length up to 6 ft.
- Socket openings any size or shape.

- Engineered for quality performance.



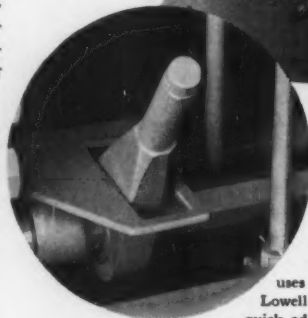
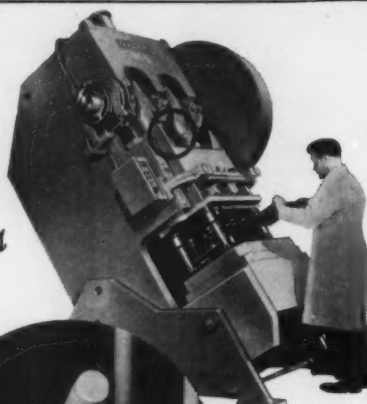
WRITE TODAY FOR TECHNICAL DATA

LOWELL WRENCH CO.

93 Temple Street

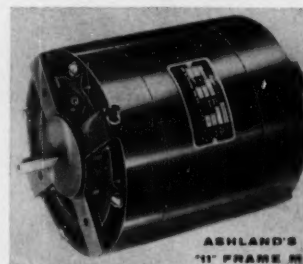
Worcester 4, Massachusetts

Circle 325 on Page 19



This Niagara double crank gap frame press for long die area work uses a special built-in Lowell Series 20 Wrench for quick adjustment of the slide.

NEW PARTS AND MATERIALS



range from 1/150 at 900 rpm to 1/3 at 3300 rpm, depending on the application. Lengths range from 3 13/16 to 6 13/16 in., with motor diameter remaining constant at 4 3/8 in. Ashland Electric Products Inc., Dept. MD, 32-02 Queens Blvd., Long Island City, N. Y.

Circle 557 on Page 19

Permanent Magnet

has high resistance to demagnetization

Alnico VIII permanent magnet has over twice as much resistance to demagnetization as Alnico V, and is substantially higher in both coercive force and maximum energy product than Alnico VI or VII. Applications include motors and generators, flat-type speaker structures, permanent-magnet cores for meters, magnetic separators, and focusing of electron beams. Crucible Steel Co. of America, Dept. IS, P. O. Box 88, Pittsburgh 30, Pa.

Circle 558 on Page 19



for -100° F to 500° F applications

Select the right Temp-R-Tape for your job from a variety of types which combine some form of Teflon, Fiberglass or Silicone Rubber backing with a silicone polymer adhesive. Temp-R-Tapes possess high dielectric strength, thermal stability, excellent moisture resistance, non-aging characteristics and many other desirable properties.

CLASS H INSULATION USES: slot lining; interlayer and interphase insulation; harness bundling; splicing; wrapping for microwave components, transformer coils, capacitors and high voltage cables.

NON-STICK USES: non-stick facings for film guides in electronic instruments, heat sealing bars, forming dies, chutes, guide rails, etc.

AVAILABLE FROM STOCK: 1/4" to 2" widths, 18 yd. and 36 yd. rolls and 12" width on liner by lineal yard. Sold through distributors.

FREE SAMPLE and folder — write, phone or use inquiry service.

ELECTRICAL AND INDUSTRIAL SPECIALTY TAPES

CHR CONNECTICUT HARD RUBBER CO.

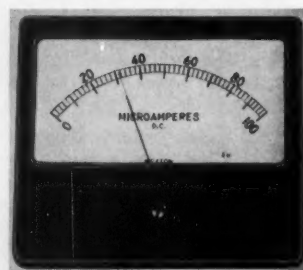
*duPont TM

Main office: New Haven 9, Connecticut

Panel Instruments

in clear-plastic rectangular or Bakelite cases

Model 1900 ac and dc panel instruments feature a common base and shell for various mechanism types. Meters are available in rectangular cases of clear plastic or Bakelite, with optional 1 or 2 per cent ac-



MACHINE DESIGN



FORMULA FOR FLEXIBLE ANALYSES

LOOKING FOR A SPECIAL COMPOSITION in your steel tubing...perhaps in limited quantities? Then ACIPCO is the ideal source! Here are complete facilities plus the newest process*...ACIPCO CERAM-SPUN®...for producing centrifugally spun tubes to meet the most rigid specifications.

CONSIDER THESE ADVANTAGES: 1. Electric furnaces, both arc and induction type, are available in a variety of capacities...heats can be sized to produce the exact footage required. 2. With minor modifications for castability, all carbon and low alloy steels can be furnished in compliance with the chemical composition limits of SAE and AISI Standards. Special ferritic chromium-molybdenum alloy steel tubes are manufactured to meet the requirements of ASTM Specification A426-58T. 3. All

ACI corrosion resistant and heat resistant alloys...as well as Cast Monel and ARMCO 17-4 PH...are available.

4. Also, gray and alloy cast iron and all grades of AMERICAN DUCTILE IRON® (including the austenitic grades) are regularly cast as pipe, tubes, fittings and specials in all sizes and thicknesses.

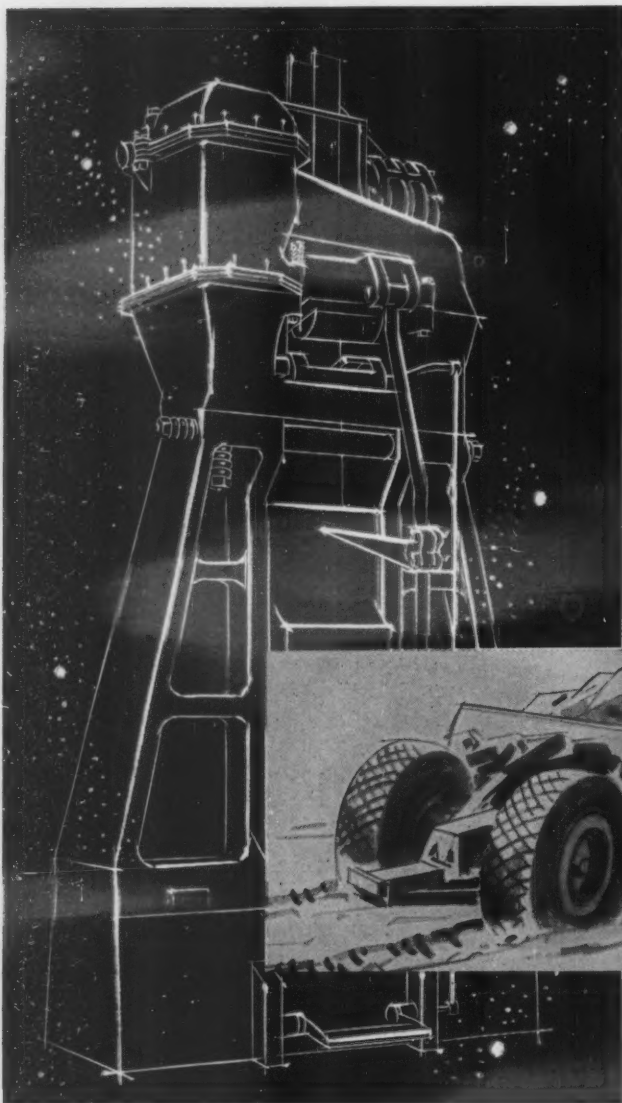
IN ADDITION, ACIPCO offers a wide range of sizes, with O.D.'s from 2.25" to 50". Wall thicknesses vary from .25" to 8"; as-cast lengths from 4 feet to 20 feet; longer lengths can be made by welding.

If you design, manufacture or use parts requiring tubular metal components, it will pay you to investigate the other advantages ACIPCO offers. For complete facts, contact ACIPCO STEEL PRODUCTS, Division of American Cast Iron Pipe Company, Birmingham 2, Alabama.

*Patent applied for

ACIPCO CERAM-SPUN®
STEEL TUBING 

Circle 327 on Page 19



Modern board forging hammer

DEPENDABILITY of shifter fork improved by designing it to be FORGED



By designing the shifter fork of his transmission to be forged, a manufacturer of earthmovers eliminated costly equipment breakdowns in the field because of fork failure. Factor of safety was *increased* even while weight and over-all costs were being *decreased*.

Parts scrapped because of voids uncovered after much high-cost machining are eliminated... forgings are *naturally* sound all the way through. Forgings start as *better* metal... are further *improved* by the compacting hammer-blows or high-pressure of the forging process.

Design your parts to be forged... increase strength/weight ratio, reduce as-assembled cost, improve performance. Literature to help you design, specify, and procure forged parts is available on request.

When it's a vital part, design it to be



Drop Forging Association • Cleveland 13, Ohio

Names of sponsoring companies on request to this magazine

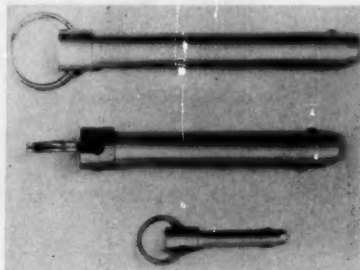
curacy in either case style. Line comprises ammeters, milliammeters, microammeters (shown), and voltmeters. Case sizes include $4\frac{1}{2}$, $5\frac{1}{2}$, and $7\frac{1}{2}$ in., with 100 deg arc scales and black printing on white dial. Weston Instruments Div., Daystrom Inc., 614 Frelinghuysen Ave., Newark 12, N. J.

Circle 559 on Page 19

Detent Pins

in $\frac{1}{4}$ to 1-in. diam

Ball-Lok detent pins are available in Type 4130 alloy steel and Type 303 stainless steel. Diameter sizes range from $\frac{1}{4}$ to 1 in., with grip lengths in $\frac{1}{10}$ -in. increments. In the solid shear pins, balls are spring



loaded, and opposite placement of the balls equalizes pull forces, which prevents jamming. Simple push-pull action assures positive-control detent action, and safety-shouldered head shields the pull ring from damage. High shear loads are possible through the solid-shank design. Avdel Inc., 210 S. Victory Blvd., Burbank, Calif.

Circle 560 on Page 19

Quick-Connect Couplings

for heavy-duty industrial uses

Roto Lock Industrial Series 12, 13, 14, and 15 quick-connect couplings are available for heavy-duty applications. In disconnect position, positive sealing action is assured by heavy stainless-steel springs and O-rings recessed in the valves. Design of the locking cam provides fast, direct locking action. All coupling and uncoupling action is rotary. Coupling is available from $\frac{1}{4}$ through 3-in. sizes with internal pipe thread, male pipe thread, and commercial hose-end fittings. Ma-

SMITH

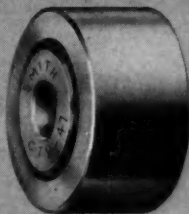
CAM FOLLOWERS AND YOKE ROLLERS



HCS CAM FOLLOWER



CTA CAM FOLLOWER



CTY YOKE ROLLER

Precision Made For Precise Performance

Each component of Smith Cam Followers and Yoke Rollers is carefully engineered, machined and finished to the most exacting standards and dimensions. As a result, each Standard Smith Cam Followers and Yoke Roller is identical to all others of the same series and size.

Such uniformity of product results in equal uniformity of performance

Standard Smith "CTA" (Interchangeable) or "HCS" (High Capacity Stud) Cam Followers and "CTY" Yoke Rollers, assure you of outstanding performance with long, trouble-free life.

Special Smith Cam Followers and Yoke Rollers to suit special applications are supplied promptly.

Better distributors throughout the nation stock and sell Smith Cam Followers and Yoke Rollers.

Write for your new, quick reference data sheets.

SMITH BEARING DIVISION

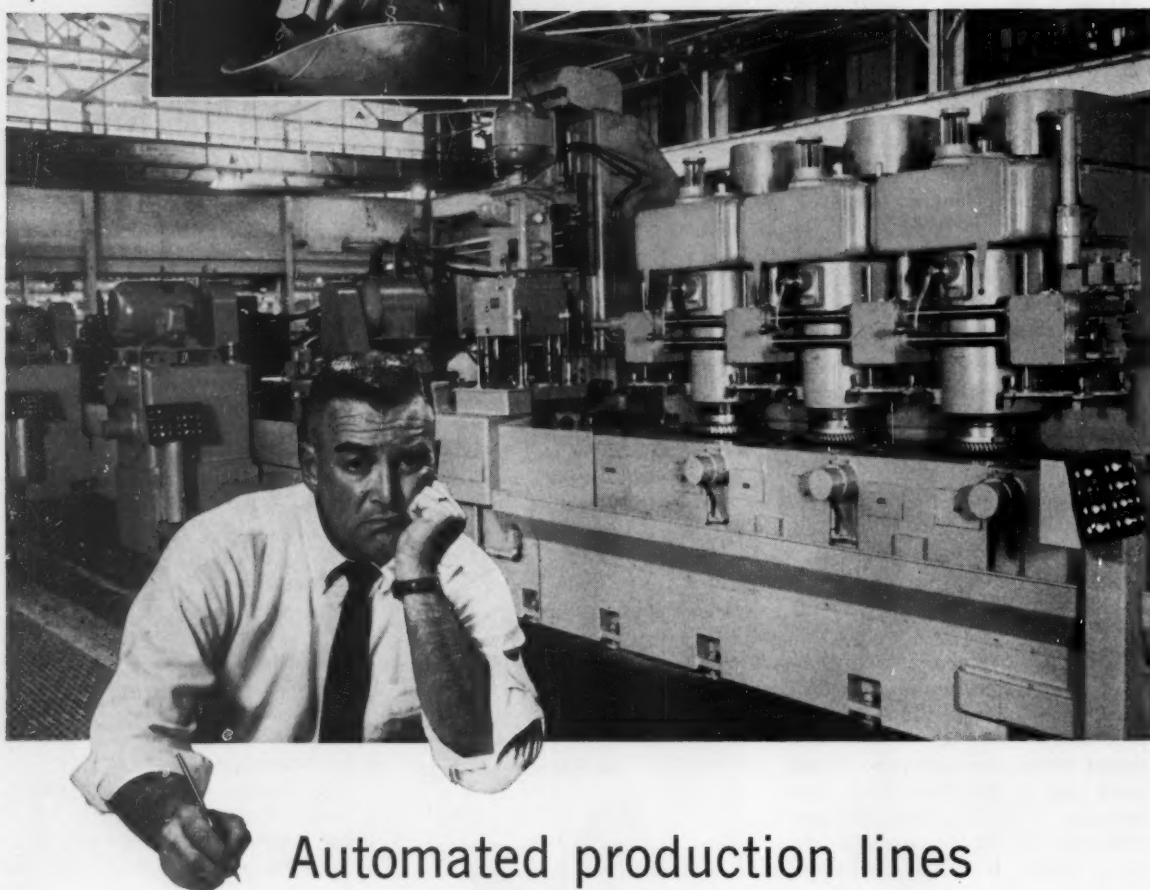
Accurate Bushing Company

441 North Avenue, Garwood, New Jersey

Manufacturers of: Needle Bearings, Cam Followers, Yoke Rollers, Jet Engine After Burner Rollers and Bearing Assemblies, N. A. S. Standard and Special Bearings, High Temperature and Severe Wear Precision Parts.

MOTORS
BY THE
POUND?

*You're buying motors by the pound
when price is the only consideration*



Automated production lines multiply the cost of motor failure

Automated production lines can't afford motor drives selected on the basis of price alone. For when a group of machines are linked in series, with each dependent on the preceding machine to supply it, a motor failure in the line quickly multiplies the cost of downtime.

Wagner® totally-enclosed, fan-cooled Type EP and JP motors are perfect power packages for automated lines. They are completely protected against dust, abrasives, fumes, steel chips, or filings. Both ends of these motors have running shaft seals to keep their heavy-duty bearings clean. These Wagner motors will keep your pro-

duction rates up, delivering full rated horsepower under the toughest conditions . . . staying on the job with continuous service. They have earned their reputation for proven dependability.

Next time you buy motors, check beyond the purchase price. Make sure that you get all the performance you need—with motors that will do the job.

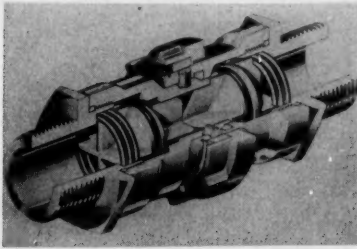
Wagner motors have been getting the job done for more than 65 years. Your Wagner Sales Engineer will be glad to show you why. Call him for an analysis of your next motor application, be it for plant or product.

Branches and Distributors in all Principal Cities

Wagner Electric Corporation

6404 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

WH61-2



materials are alloy steel, brass, bronze, stainless steel. Jack & Heintz Div., Siegler Corp., 17601 Broadway, Cleveland 1, Ohio.

Circle 561 on Page 19

Dry Lubricant

is insoluble in
known organic solvents

Drilube 822 consists of a low-molecular telomer of Teflon, fluoroalkyl ester, and fluorinated hydrocarbons. Material is used as a thread lubricant and sealant on AN and pipe threads. It is an excellent lubrication on plain bearings where compatibility with the working fluid is a problem. A further application is on rubber O-ring surfaces for ease of installation. Lubricant is insoluble in any known organic solvent as well as water. It is a translucent white paste, compatible with LOX and hydrazine. Drilube Co., 723 W. Broadway, Glendale 4, Calif.

Circle 562 on Page 19

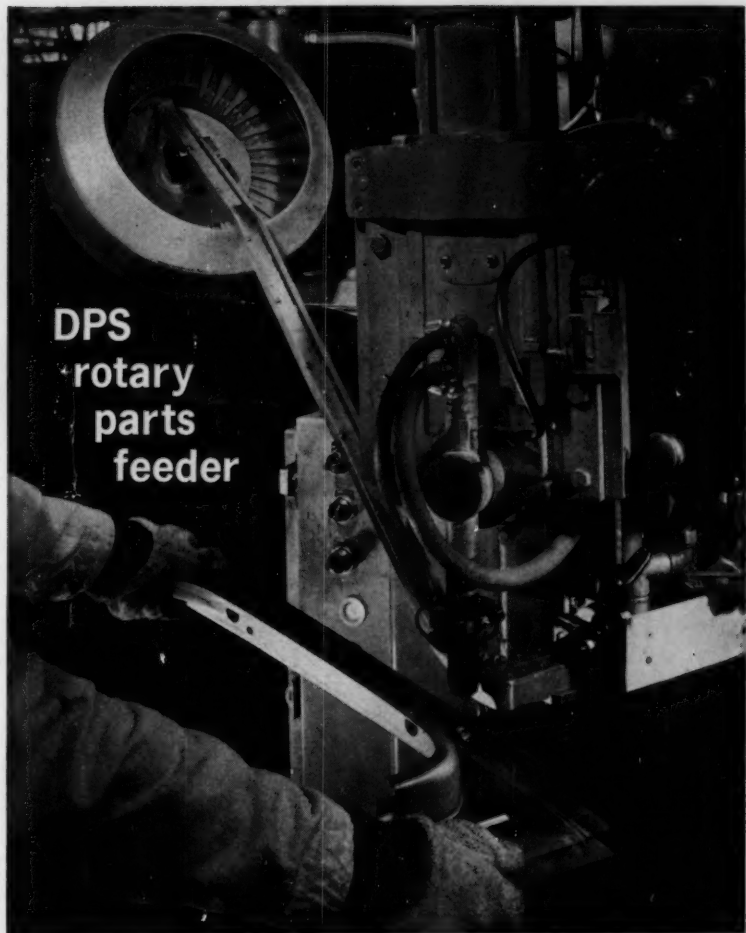
Circuit-Board Retainer

holds board under
3g shock load

Retainer for printed-circuit boards eliminates grooving operations in electronic module construction. Two lanced tabs in the design prevent vibration to boards and hold board under a 3g shock load. Material is beryllium copper, cadmium plat-



July 20, 1961



doubles nut welding output in sub-assembly production line

In this sub-assembly operation, production of the welding equipment was limited because the weld nuts had to be hand positioned. When the DPS rotary parts feeder took over the feeding operation, nut welder output was doubled.

Savings and efficiencies such as this are being effected in assembly operations throughout industry. Parts of a variety of sizes, shapes and materials are successfully being handled in DPS rotary, vibratory and elevating type parts feeders . . . industry's most complete line. Parts ranging from common bolts, nuts and screws to the many more unusual pieces that are used in the complex machinery of today.

DPS engineers welcome the opportunity to work with your engineers in analyzing assembly problems and production line procedures. They will recommend the one best feeder to effect lower manufacturing costs and improved product quality. Write or call today. Ask for free catalog.



DETROIT POWER SCREWDRIVER CO.

A Subsidiary of Link-Belt Company

Selective Parts Feeders; Screw, Nut and
Stud Driving Machines;
Special Purpose Assembly Machines

2801 W. Fort Street
Detroit 16, Michigan
TAshmo 5-3070

15,802

Circle 331 on Page 19

209

the NEG'ATOR Data Book

HUNTER
Science in Springs
2.
**EXTENSION
SPRINGS**

Using NEG'ATOR Extension Springs to Push, Pull, Lift, and Return



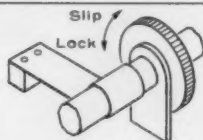
1. The NEG'ATOR spring is a strip of spring steel formed into a prestressed coil. It resists uncoiling with a uniform pull—provides a truly constant-force spring of practically unlimited length.



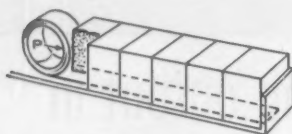
2. Used to counterbalance, provide tension, or act as a retracting device, it saves space and weight and eliminates cumbersome linkages. Here, two springs are used back-to-back as a counterbalance.



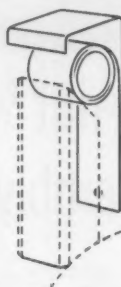
3. NEG'ATOR bands are used as oscillating motion transmitters to replace gears and cables. They eliminate backlash and slippage and provide smooth, quiet operation with many turns per cycle.



4. As a one-way clutch or brake, the NEG'ATOR prevents counter clockwise rotation of shaft as spring tends to grip more tightly. Clockwise rotation expands coil, lets shaft slip.

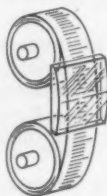


5. Used as a feeding device for data cards or merchandise, the NEG'ATOR spring saves space and acts over a long range. The coil pushes with unvarying force all the way.



6. The NEG'ATOR spring makes an ideal constant-pressure device. Used in this manner, it eliminates mechanisms for "setting-up" commutator brush springs, for example. In addition, it saves space, and cuts costs.

7. The surface of a NEG'ATOR spring can be printed and used to provide a scale of great length in a small space. Because each end tends to wrap around its bushing, the band acts as a "balanced" self-coiling scale.



How to use it?

■ Window sash balances, vending machines, compression testers, commutator brush holders, door closers, duplicating machines and countless other mechanical and electrical products employ NEG'ATOR extension springs. Write for literature.

The NEG'ATOR spring is a development of Hunter Spring Company.

HUNTER SPRING COMPANY

A Division of American Machine and Metals, Inc.
3 Spring Avenue, Lansdale, Pennsylvania

DIVISIONS OF AMERICAN MACHINE AND METALS, INC.: Troy Laundry Machinery
Riehle Testing Machines • De Bothezat Fans • Tolhurst Centrifugals • Filtration Engineers • Filtration Fabrics
Niagara Filters • United States Gauge • Rahm Instruments • Lamb Electric Co. • Hunter Spring Co. • Glasser-Steers Corp.

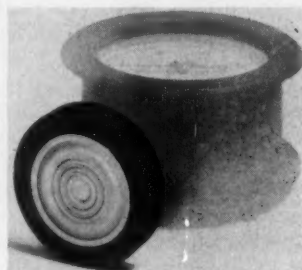
NEW PARTS AND MATERIALS

ed, which permits secondary functions of providing a heat path for thermal convection and as an electrical ground return. Boards are mounted in the spring-loaded retainer in a vertical movement with easy insertion provided by a flanged opening at one end. Retainer grips board in both directions. Standard length of the stock retainer is 4 1/4 in. for 3/32 or 1/16-in. boards. Variations in lengths and designs are available for retention to 10g. Industrial Div., Birtcher Corp., 745 S. Monterey Pass Rd., Monterey Park, Calif.

Circle 563 on Page 19

Welded Diaphragm Seals

for use in
pressure instruments



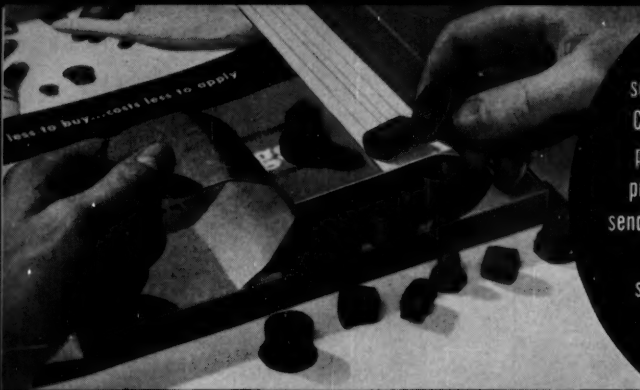
Welded diaphragm seals, available in a variety of designs and diaphragm materials, are all the clean-out type. They prevent corrosion or clogging of pressure instruments. Thin-metal diaphragm is welded to the thicker top flange, eliminating leakage. Machined shape reduces the internal volume for a minimum of temperature error. Diaphragm cannot be distorted or blown out. Mansfield & Green Inc., 6185 Cochran Rd., Cleveland 39, Ohio.

Circle 564 on Page 19

Shear-Pin Sprockets

protect against
destructive overloads

Stock shear pin sprockets consist of four basic parts: Sprocket, hub, shear pin, and retaining ring. As an overload occurs, the pin shears, thereby allowing the sprocket to turn free on the hub and disconnecting the drive. All units are furnished completely assembled, ready for placement on the shaft. Extra



see how
Caplugs
protect
products...
send for this
FREE
sample
kit

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2201 Elmwood Ave., Buffalo 23, N. Y.

MAIL a free assortment of Caplugs, literature and prices to us,
without obligation.

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Title

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won't chip, break,
shred, or collapse

low cost
product insurance

easy to apply
and remove

molded of tough,
flexible Polyethylene

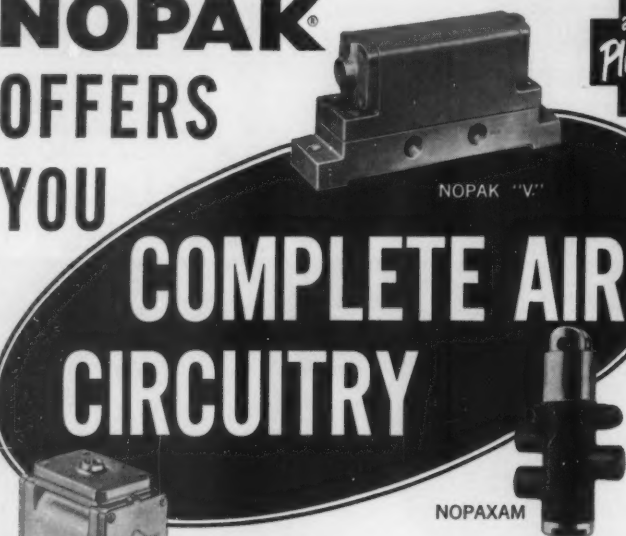
Caplugs

Quick, slick protection for
tubing, threaded fittings and machined parts
in process, storage and transit...
more than 600 sizes now in stock

NOPAK OFFERS YOU

COMPLETE AIR CIRCUITRY

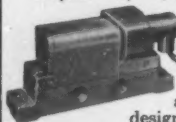
another
Plus Value
by
NOPAK



NOPAK-MATIC

The addition of Nopakam palm button, cam, lever and air operated valves "closes the Nopak circuit." Precise control — mechanically or electrically signaled — can now be completely Nopak. Singularly or in combination, Nopakam, Nopak "V" valves and Nopak-matic valves will meet your most complex circuit requirements.

Nopak "V," 4-Way, Pilot Operated Slide Valves



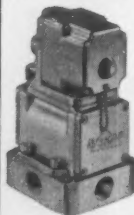
For direct or remote control. Either single or double air pilot or solenoid actuated. Simple, proven design, durable construction insure trouble free operation. See Catalog 102-A.

Nopakam Precision Spool Valves

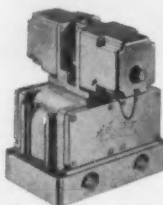
For air or hydraulic service to 150 psi. Pilot or mechanically operated, these valves are small, compact, easily mounted, have extremely short throw and high flow rates. See Catalog N.



NOPAK-MATIC Poppet-Type, Pilot Operated Valves



Fast acting, high volume air valves from 1/4" to 1 1/4" with master (air piloted), single or double solenoid. Side or bottom ported sub-plates or manifolds. Removing cover plates affords easy access to piston poppets housed within removable, interchangeable cartridges. 100% J.I.C. See Catalog 105.



Other NOPAK "CVA*" Products

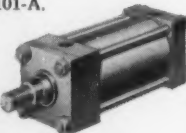
NOPAK Class 1 Cylinders



Brass Tubing and Tie-Rod Construction. For pressures to 250 psi. Choice of adjustable cushion, self-regulating or non-cushion heads. Diameters from 1 1/4" to 16". 6 Standard Mountings. See Catalog 101-A.

NOPAK Class 6 Bore-Rated Cylinders

Compact steel plate, square head with tie-rod and honed steel tubing construction. For air pressures to 250 psi, hydraulic pressures to 1500 psi. See Catalog 106.



NOPAK Class 7, Square Barrel Cylinders

Made with pressure-cast and extruded aluminum. Mounting holes can be drilled or tapped directly into cylinder tubing. 3/4" to 3" bores pressure rated for 200 psi. air or 1000 psi. oil. 7 universal mountings. See Catalog 107.



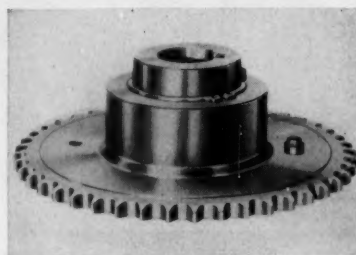
*CVA Cylinders, Valves, Accessories
NOPAK offers a complete line of Matched Fluid Power Components.



NOPAK DIVISION

Galland-Henning Mfg. Co.
2752 S. 31st St., Milwaukee 46, Wis.

NEW PARTS AND MATERIALS



shear pins are also supplied with each unit. Chain Belt Co., Milwaukee 1, Wis.

Circle 565 on Page 19

Polyethylene Tubing

is unaffected by
most chemicals

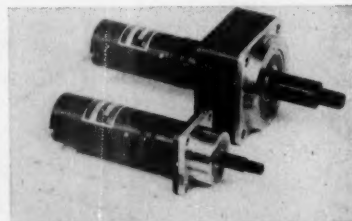
Synflex P-1 polyethylene tubing is suitable for air, gas, water, and chemical lines, in either permanent or temporary hookups where low-cost, flexible connections are required. Tubing is unaffected by most chemicals including concentrated hydrochloric, sulphuric, and hydrofluoric acids. Tubing is available in 1/4, 3/8, and 1/2-in. OD. Synflex Products Div., Samuel Moore & Co., Mantua, Ohio.

Circle 566 on Page 19

Gear Motors

have new planetary
gearing system

For use with 1 1/2-in. precision motors, new planetary-gearing system provides up to 500 lb-in. of torque at 8 rpm continuous duty and up to 1000 lb-in. of torque for intermittent use. Ball bearings are used at all bearing locations to provide stage efficiencies of 95 per cent or better, and gearbox rating is 1/10 hp. System offers a choice of 18 reduction ratios from 1.87:1 to 941:1 in the smaller design. For use with the 3 in.-square mounting flange, choice of 10 ratios from 219:1 to 5211:1 is available. By





Want to find the coefficients? It's easy with the new Regression Analysis program for the IBM 1620

Here's another program offered free-of-charge to users of the IBM 1620 Data Processing System. It gives you the kind of results you might expect only from a much more expensive computer. But users of the 1620 know that its low rental cost is deceptive. The 1620 packs *more computing power per cubic inch* than any other computer in its size range.

The Regression Analysis program is a good example. Suppose you want a fit for production purposes. If you employ more than two variables you probably have difficulty visualizing the representation of your data. If linearity is not the case, you must often guess blindly at a polynomial of high degree, accept or reject the fit with some-

thing approaching a sixth sense, and either try again or settle for the results you have.

The new Regression Analysis program lets you handle expressions containing up to 24 variables. If you have the even more complicated task of handling many dependent variables, the program will generate regression coefficients with a maximum number of dependent variables not exceeding one-half the number of independent variables.

This program will also fit non-linear functions and hyper-surfaces. Compare this performance with that of any other computer in the 1620's price range.

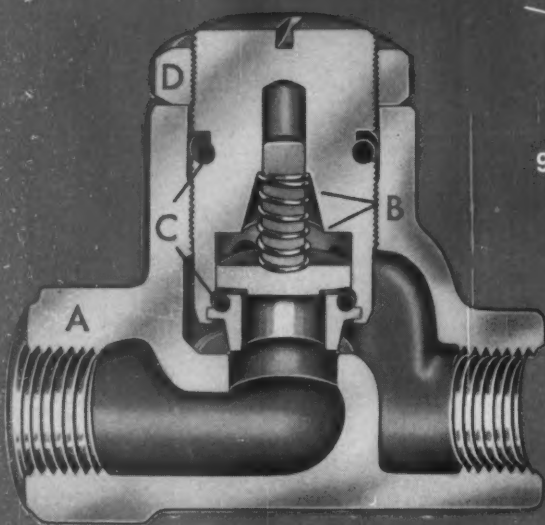
A basic 1620 installation rents for just \$1600 per month. For details, contact your local IBM Representative.



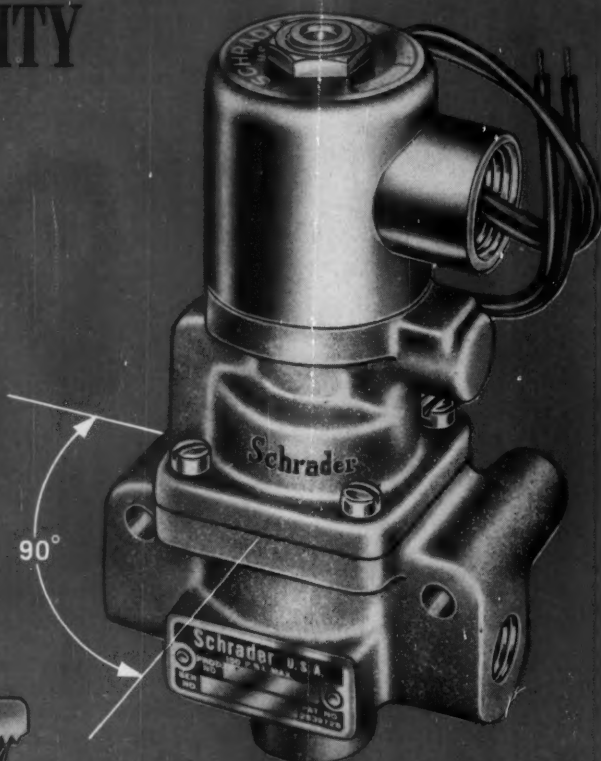
IBM's 1620 is a compact desk-size computer.

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DATA PROCESSING

THERE'S A QUALITY DIFFERENCE IN AIR CONTROL COMPONENTS...



FOR EXAMPLE: Schrader Flow Control Valves—a unique combination of a poppet by-pass valve and a large “cone seat” metering valve provides full air flow in one direction and carefully controlled flow in the other. (A) Body of cast brass. (B) Compact plunger assembly replaceable in one unit. (C) “O” ring seal for surest airtight performance. (D) Extra-fine screw thread adjustment for vernier-like setting and sturdy lock-nut to hold adjustment even under rough treatment.



*...you can see the
difference in any
Schrader Air Product*

ANOTHER EXAMPLE: Solenoid-operated 3-way Valves by Schrader permit electric control of air power and make possible new versatility and compactness in automation and machine design. Typical feature . . . by shifting pilot chamber head 90° a normally-open type may be changed to normally-closed, and vice versa. This poppet type valve, has a self-cleaning seat and provides full air flow assuring optimum characteristics for cyclic operations. Available in five pipe sizes from 1/4" to 1".



FULL LINE OF QUALITY AIR CIRCUIT COMPONENTS • OFF-THE-SHELF SERVICE AND INFORMATION FROM YOUR NEARBY DISTRIBUTOR • STAFFED WITH AIR CIRCUIT EXPERTS • CONSULT YELLOW PAGES OR WRITE FOR HIS ADDRESS

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A. SCHRADER'S SON
Division of Scovill Manufacturing Co., Inc.
476 Vanderbilt Ave., Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS

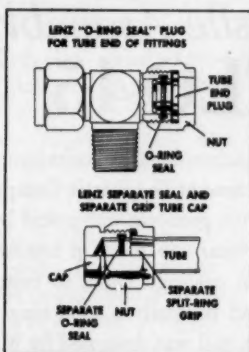
selection of proper motor winding, virtually any desired speed reduction can be obtained. Globe Industries Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 567 on Page 19

Plugs and Caps

for fittings and tube ends

New plug closes off the tube end of a fitting. It goes inside the fitting in place of the tube, with O-ring doing the sealing and shoulder of the nut serving to hold and grip plug separately from the seal. No sleeve is needed. Unit installs quickly and easily and is re-usable. Cap fits and closes off the end of



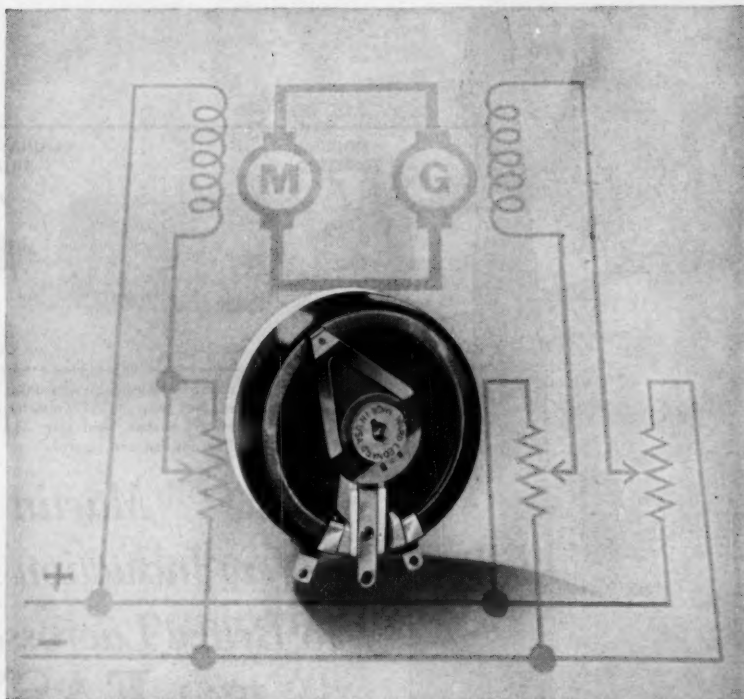
the tube. O-ring seals tube separately from split-ring grip. Flaring, threading, and soldering are not required, and tube end need not be cut square. Plug and cap assure a safe, leakproof connection when a fitting or tube needs to be closed off temporarily or permanently. Caps or plugs are available in sizes from 1/4 to 2 in. tube OD. Lenz Co., 3301 Klepinger Rd., Dayton 1, Ohio.

Circle 568 on Page 19

Low-Power Rectifiers

in ratings to 750 ma maximum forward current

Series 1N536 low-power silicon rectifiers are suited for applications such as in magnetic amplifiers, precision metering, ring modulators, high-Q circuits, and test equipment. They are available in ratings to 750 ma maximum forward current and range in peak reverse voltages from 50 to 1000 v. Rectifiers operate in



Background is schematic of world-famous Ward Leonard system of control.

In modern rheostat circuits, it's SERVICE CONTINUITY THAT COUNTS

Production stopped. Workers idle. But wages, maintenance costs, and fixed charges go merrily on accumulating.

That's the black picture when an industrial control component—specifically a rheostat—fails. That's why reliability is more important than initial cost. In many cases, these irrecoverable charges and costs can quickly far exceed the replacement cost of the faulty components.

And that's why far-sighted designers are more and more specifying Ward Leonard VITROHM ring rheostats for control circuits where performance is a must...in motor and generator field control circuits...for electronic tube filament circuits...wherever substantial amounts of power must be handled with utmost rheostat reliability.

Ward Leonard ring rheostats, in sizes of 25, 50, 100, 150 and 300 watts, feature W/L's exclusive "twin contact shoe" design. Two sintered, self-lubricating contact shoes minimize wear and assure uniform contact pressure, smooth oper-

ation, and maximum reliability.

Special alloy resistance wire—made to W/L's closely monitored specifications to assure highest stability and lowest practical temperature coefficient—is bonded permanently to ceramic core by Ward Leonard's own VITROHM vitreous enamel.

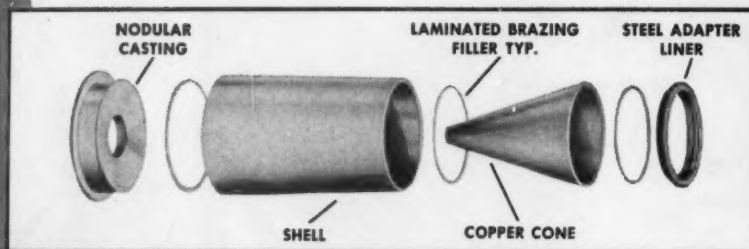
These are just a few of the reasons why VITROHM ring rheostats give you outstanding reliability in industrial control circuits. There are many more quality-engineered features than we can describe here—for instance, highest grade ceramic base and core, durably bonded tinned alloy terminals, and balanced beryllium copper contact arm. You'll find them all in Bulletin 60RR (and for powers above 300 watts, check W/L plate rheostats in Bulletin 60A). For your copy, and for a list of stocking distributors, write: Ward Leonard Electric Co., 58 South St., Mount Vernon, N.Y. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)

c.s.



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RESISTORS • RHEOSTATS • RELAYS • CONTROLS



The four components of the nose assembly—nodular iron casting; low-carbon welded steel canister which measures 34" long, 15½" diameter at one end and 17¾" at the other; spun copper cone and low-carbon steel ring. The thinner rings are Easy-Flo 45 wire braided for precise alloy position and control.

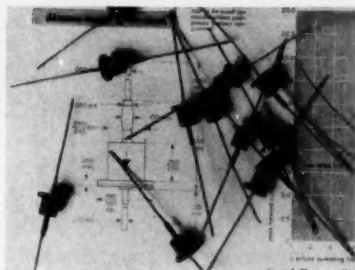
*Martin Develops New Induction Heating Methods to Braze Lacrosse Missile Assembly With **EASY-FLO 45***

One of the largest assemblies yet brazed by induction-heating techniques is a section of the Lacrosse missile being manufactured at The Martin Company's Baltimore Division. During development, one problem was posed by the variety of metals used. First it was necessary to braze a low-carbon welded steel canister and nodular iron casting. Then, to complete the assembly, a spun copper cone and low-carbon steel ring were joined to the canister. An induction coil was designed by Martin to accomplish this critical operation. Temperatures had to be restricted between 1300 and 1350°F to prevent a transformation change to the crystalline structure of the nodular iron. Martin's Materials Engineering Laboratory made careful examinations of this assembly and found that Handy & Harman Easy-Flo 45 Silver Brazing Alloy and B-1 Flux make possible the strong, uniform joints necessary to meet the stringent requirements the Company has set. Its low-working temperature, high strength, fast penetration and flow characteristics are only a few of the features which make this brazing alloy ideal.

More and more aircraft and missile components are being made with the aid of Handy & Harman silver brazing alloys and flux. The products described here are just two of the many available to help solve your problems...make your job easier and quicker. For a more complete picture of silver brazing and the advantages it offers you, write for your free copy of Bulletin 20.

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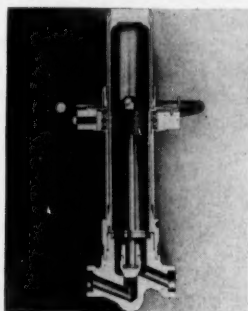
ambient temperatures from -65 to $+165$ C without the use of external heat sinks. Semiconductor Dept., Westinghouse Electric Corp., Youngwood, Pa.

Circle 569 on Page 19

Packless Valves

are globe-type units
in $\frac{1}{2}$ to 2-in. sizes

Hermetically sealed, high-temperature globe valves are offered in $\frac{1}{2}$ to 2-in. sizes. Valves have zero leakage to atmosphere and permit instantaneous changes in setting. High mechanical advantage provides high seating force and low operating torque with resultant tight seal. Normal rating for pressurized water-reactor service is 600 F at 2200 psi. Valves can be



mounted at any altitude. Harmonic Drive Div., United Shoe Machinery Corp., Balch St., Beverly, Mass.

Circle 570 on Page 19

Miniature Switch

is snap-action unit
in flat case

Series E33-00A snap-action switch has simplified coil-spring construction which provides long mechanical and electrical life with 0.050-in. minimum overtravel. Flat switch case of $1\frac{3}{32} \times \frac{5}{8} \times 13/32$ in. per-



Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive

and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66-MD.

DUFF-NORTON COMPANY

Four Gateway Center • Pittsburgh 22, Pa.

DUFF-NORTON JACKS

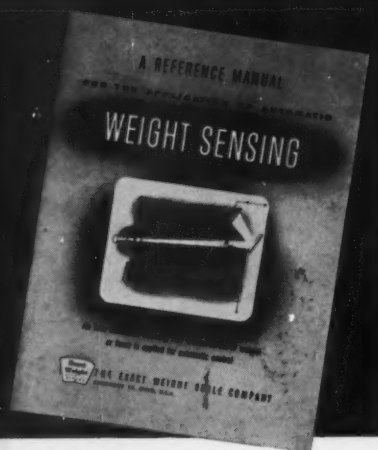
Ratchet • Screw
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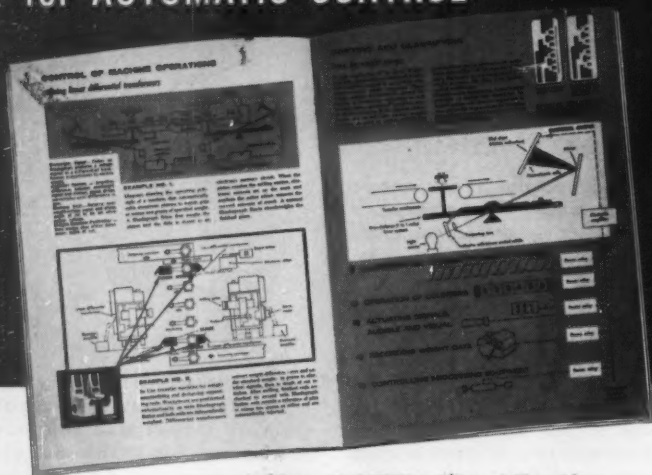
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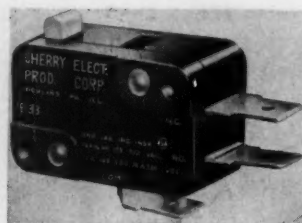
This valuable new reference manual, packed with explanatory diagrams, presents many control possibilities offered by a proven weight-sensing principle. It shows how the principle is applied for control of basic operative functions in automated machines; for control of processing equipment; and for quality control operations. Here is a source of ideas that can lead to the solution of problems concerned with weighing or control by weights. Write for your free copy of "Weight Sensing."



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923 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: 5 Six Points Road, Toronto 18, Ont.

Circle 340 on Page 19

NEW PARTS AND MATERIALS



mits individual or gang assembly use for multiple-cam operation. Rock-Wipe contact action provides accurate repeatability and precise tolerance adherence. Switch is rated 10 amp, 1/2 hp, 125/250 v ac. Cherry Electrical Products Corp., 1650 W. Deerfield Rd., Highland Park, Ill.

Circle 571 on Page 19

Low-Alloy Steel

has 70,000 psi
minimum tensile strength

Low-alloy steel combines high strength, excellent forming qualities, good weldability and resistance to atmospheric corrosion. It is a nickel-copper-titanium steel with 50,000 psi minimum yield point and 70,000 psi minimum tensile strength. It offers up to four times as much resistance to atmospheric corrosion as does carbon steel. In a realignment of high-strength grades, the new grade replaces Jalten 1. High-strength grades are available in hot and cold-rolled sheets, galvanized sheets, hot-rolled bars and small shapes, regular plates, and floor plates. Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.

Circle 572 on Page 19

Brakes and Clutches

in sizes 6 and 8

Clutch-neutral brakes and clutch-neutral clutches in sizes 6 and 8 have been added to a line of subminiature clutches and brakes. They are suitable for computer, control, and servo-positioning systems where size-weight ratios are critical. General characteristics include: Zero backlash and endplay; elimination of slip rings; no angular displacement or axial motion during braking or clutching; and concentricity of input and output shafts within 0.0015-in. TIR of the servo mounting pilot. ABEC-5 or better ball

MACHINE DESIGN



Check these reasons why Ohio Drawn-Welded is your best buy

- ✓ OHIO is your most complete source for drawn-welded tubing—from $\frac{3}{8}$ " to $7\frac{1}{4}$ " OD, from .028 to .344 wall thickness.
- ✓ OHIO has the most modern welded tube mills in operation today, backed up with 25 years of experience in the production of quality welded steel tubing.
- ✓ OHIO DRAWN-WELDED is a guaranteed product of Ohio Seamless Tube, SHELBY, OHIO, U. S. A., capital of steel tube production since 1890.
- ✓ At OHIO, welded and seamless tube production is *integrated*. The same practices, craftsmanship and facilities are employed to complete the processing of drawn-welded as we use on our seamless product, which is world-famous for its reliability.
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on parts
and
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This book describes the Bridgeport Cored Forging Process, and tells how weight, machining or assembly can be reduced on simple or complex parts.

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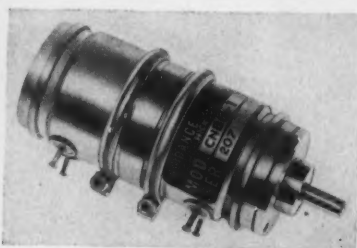
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| ✓ | less machining to finish |
| ✓ | no assembly required |
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| ✓ | less finished weight |
| ✓ | multiple coring |
| ✓ | lower cost plating |
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CORED FORGINGS DIVISION
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BRASS COMPANY
1000 Connecticut Ave., South Norwalk, Conn.

Circle 342 on Page 19

NEW PARTS AND MATERIALS



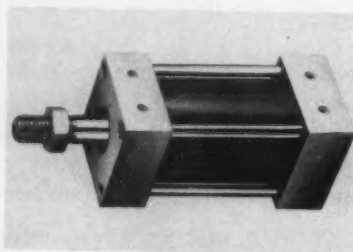
bearings are used throughout. Low power consumption of these units, approximately 2.5 to 3.0 w at 24 v dc, extends operational life. Standard units operate over a temperature range of -55 to +120 C. Guidance Controls Corp., 110 Duffy Ave., Hicksville, L. I., N. Y.

Circle 573 on Page 19

Air Cylinder

has nylon and
Delrin bearings

Series D cylinder is available for 250-psi air service. Cylinder barrels of chrome-plated steel with a 4 mu in. finish provide maximum sealing power and minimum friction. Low-friction nylon and Delrin bearings alleviate scoring and prolong the life of both cylinder wall and piston rod. Horizontal flush, front flush, and rear flush mountings can be furnished. Rod clevis and pin, swivel mount and



pin, pivot mount, foot mount, and flange mount are readily attached to the basic three-way mount to meet most mounting requirements. Alkon Products Corp., 200 Central Avenue, Hawthorne, N. J.

Circle 574 on Page 19

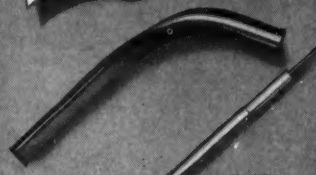
Terminal Bushings

in fluted and
tubular types

Three series of fluted and four series of tubular terminal bushings are for use where silver solder,

TUBING

STRAIGHT... PREFORMED OR COAXITUBE



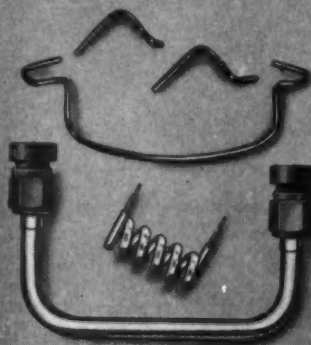
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TO YOUR SPECIFICATIONS

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PRECISION
TUBE COMPANY

Circle 343 on Page 19

HOKE Flow Sheet⁵

HOKE REPORTS ON FLUID CONTROL

WE'VE TOSSED A NEW BALL INTO AN OLD GAME

A VALVE NAMED "DESIRE"

With apologies to Tennessee Williams, we really have produced a Solenoid Valve line based on *your* desires. We surveyed all the solenoid valve users we could find to determine what *you* wanted. The result is Hoke's "User Designed" Series 90 and 95, two-way and three-way, direct-acting solenoid valve line.

Thanks to you, we have much to brag about. Here's what we have been saying about these new valves: lightest weight — smallest size — no-hum operation — lowest temperature rise — lowest power consumption — stainless steel plunger — silver AC shading coils — easiest installation — packless construction — 360° rotatable housing — operates in any position.

We make them of forged brass or stainless steel, in 1/8" and 1/4" NPT size or JIC tube ends. There's a variety of AC and DC voltages. Class "A" coils are standard, but Class "H" are also available for temperatures above 212°F. For those with high insurance rates, we can supply explosion proof coil housings.

Now that we've bragged a bit, we must also apologize for our premature enthusiasm. We were so excited about this product that we stirred up a hornet's nest of interest before we were ready to deliver in quantity. Shipments were slow at the start, but now we can have any reasonable quantity of these "desirable" solenoid valves "on-stream" in your plant when you want them.

There's only one way to get conclusive performance proof — buy a valve. Ask for Bulletin SV-4-61.



A STEADY FLOW OF FACTS!

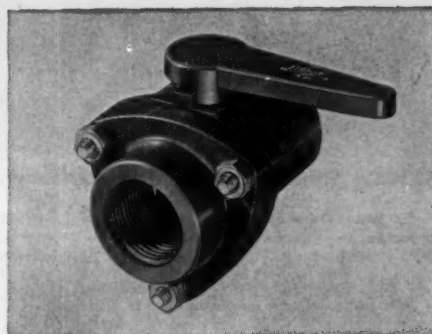
Further flow features, and interesting technical topics are carefully covered in Hoke's technical publication, the FLOW SHEET. It's free, but worth millions! To get the full benefit of our engineering and editorial efforts six times a year, mark your "X" in the proper box.

The technique of molding polyvinyl chloride into ball valve parts is old hat. Even the unplasticized compounds of type I PVC have been kicked around for a while (with minor successes). But until now, no one has booted the ball for a goal.

Perseverance, determination, and the pursuit of economic reward have prompted us to offer a line of ball valves molded of the toughest grade of type I, unplasticized PVC. There are no foreign agents to contribute to a corrosive demise, even in most caustic services. It even meets the proposed new ASTM specification and has a tensile strength of 8500 psi. Those who have had PVC piping problems will profit from the new molding process that gives these Hokes dimensional stability and very high impact strength. Sensitive systems, human and otherwise, are safe from contamination — they're absolutely non-toxic. We've set 140°F. as the operating temperature limit, but occasional excursions to 160°F. won't do any harm.

All standard models are supplied with a concentric hole drilled thru the ball. They can be heat welded, or solvent bonded right in the line. Piping hook-up is even simplified by their coupling-like assembly. Your assistant can fit each half of the valve to a pipe end, then reassemble the valve without having to turn the pipe. Pressures to 125 psi are duck soup for these valves.

A maintenance man's delight, they can be cleaned and have their seats changed without leaving the pipe. Their light weight makes them ideal for use on long, unsupported spans of pipe.



Size-wise, we're offering them in 1/2, 3/4, 1, 1 1/2, 2, and 3 inch sizes, all NPT female connections.

You will command the eternal admiration of your colleagues when you install these valves. Be the first to show your rightful status by ordering a shiny new Hoke polyvinyl chloride ball valve. If pride of ownership hasn't motivated you at this point, the mere fact that you are behind the scientific times should move you to find out more.

It isn't necessary to tell us why you want the additional information. Just check the coupon below. We'll forward the facts in a plain, brown envelope.

'61 PRODUCT PARADE

You'd be surprised at some of the screwball ways our valves have been used (to decided advantage, of course). Hoke distributors are armed to their maxillary third molars with this method madness and will redesign your systems (incorporating solenoid valves and PVC ball valves) at the drop of a postcard. Check the PRODUCT PARADE box.

Hoke's Performance Guarantee — Every Valve Leak-Tested!

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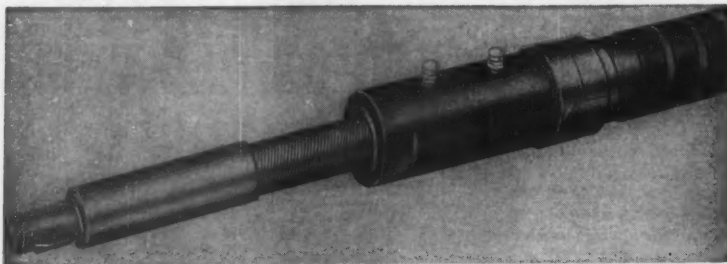
Send me complete information on the Hoke products checked below:

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- ☐ Solenoid Valves
- ☐ Product Parade
- ☐ Flow Sheet
- ☐ Complete Catalog GC960

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COMPANY _____
ADDRESS _____
CITY _____ STATE _____

SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE

HOW TO SELECT FLEXIBLE SHAFTING FOR POWER DRIVE APPLICATIONS



1 1/4-inch STOW Power Drive flexible shaft with core assembly pulled out of casing.

For Power Drive applications, the following factors must be considered.

1. **Torque (lb. in.)** to be transmitted. (The starting torque should be used in making selections)

2. **Operating Speeds (RPM)** — If the maximum speed is higher than the rated speed, torque ratings in the table below do not apply. To find the torque capacity for flexible shafts operating at speeds higher than the rated speeds, multiply the maximum dynamic torque capacity by the rated speed, and then divide by the operating speed. (See example.)

3. **Operating Radius**—in making the selection from the table below, the radius of the smallest bend in the flexible shaft should be used.

Ratings — The ratings for flexible shafts shown in the table below apply under the following conditions:

1. When the flexible shaft is adequately supported by clamps along its length. (For unsupported shafts, multiply the calculated torque by a safety factor of 1.6—see example below.)

2. When the flexible shaft is operated in the wind-up direction, which tends to tighten the outer layer of wires. (Flexible shafts operated in the unwind direction will transmit only about 60% of the rated torque.)

3. When the flexible shaft is in continuous operation. Note: the ratings are based on temperature rise. When the operation is intermittent, the ratings in the table may be exceeded. Consult Stow engineers for specific recommendations.

RATED SPEED R.P.M.	MAXIMUM DYNAMIC TORQUE CAPACITY (LB. IN.)									Wgt./ C. Ft.	Core Dia.	Core No. and Type	Shaft Size
	STRAIGHT AND CURVED SHAFTS												
	RADIUS OF CURVATURE IN INCHES												
	50 to Strgt.	25	20	15	12	10	8	6	5				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	3.0	.124/.128	2049 MH	13
3,800	7.0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	4.5	.148/.152	2081 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	7.0	.185/.189	5108 MH	19
2,500	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0	12.5	.247/.252	8924 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0		20.0	.308/.313	8925 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8		20.0	.308/.313	8969 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0	21.0	.324/.329	2034 A	31
1,500	80.0	66.0	63.0	58.0	51.0	46.0	37.0	22.0		28.5	.368/.374	2035 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0		29.0	.387/.393	8970 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0		29.0	.387/.393	8971 T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0			50.5	.497/.503	8999 A	50
1,150	148	124	110	92	72	56				53.5	.505/.511	6940 T	50
900	248	200	176	124	84					78.5	.610/.618	6997 T	63
900	220	204	192	180	152	130				80.5	.630/.638	7731 A	63
750	340	224	156	76						117	.747/.753	2056 T	75
600	760	520	420							205	.998/1.004	2057 T	100
440	1,500	720								343	1.298/1.304	2058 T	125

EXAMPLE—How to use the table:

The problem is to transmit 1/2 HP at 1700 RPM through an unsupported flexible shaft in a 25" radius, estimated starting torque 150% of normal operating torque.

1. Calc. Torque (lb. in.)—

$$\text{HP} \times 63000 \div \text{RPM} = 18.5$$

2. Correction factor for starting torque
1.5 × 18.5 = 27.75.

3. Correction factor for unsupported shaft
27.75 × 1.6 = 44.4 lb. in.

4. Refer to Table above. Read downward in column under 25" radius until you find a core having a rating of at least 44.4 lb. in. In this case we find that Core No. 8970 is rated 54 lb. in. at 1500 RPM. Since the given speed is 1700 RPM, multiply 54 by 1500 and divide by 1700. 54 × 1500 ÷ 1700 = 47.6 lb. in. (rated torque at 1700 RPM). Therefore, Core No. 8970 is correct.

For Engineering Bulletin No. 570 and a free torque calculator, write
STOW MANUFACTURING CO.



11 Shear Street • Binghamton, New York

NEW PARTS AND MATERIALS

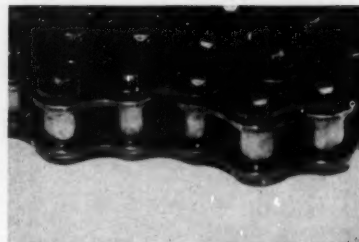
brazing, or welding of terminal assembly to container is made necessary by higher operating temperatures than can be withstood by soft solder seals. Insulator bodies are 94 per cent alumina, glazed on external surfaces. All metallized areas are prepared by application of high-temperature metallized coating. Frenchtown Porcelain Co., Frenchtown, N. J.

Circle 575 on Page 19

Self-Lubricating Chains

are available in 1-in. pitch

MSL self-lubricating power transmission and conveyor chains in single, double, triple, and quadruple strands, in riveted or cottered type, are now available in 1-in. pitch. Average strengths range from 13,000 lb in single strand to 52,000 lb



in quadruple strands. In operation, lubricant contained within the bushing expands and flows over all vital bearing surfaces. When the drive stops, lubricant contracts and is reabsorbed by the bushing. Whitney Chain Co., Dept. MJ, 4545 S. Western Blvd., Chicago, Ill.

Circle 576 on Page 19

Flow-Rate Controller

in flow capacities from
0.01 gph to 12 gpm water

Series 8800 flow-rate controllers for purge and other flow-control and indication applications are completely self-contained. Single unit includes the rotameter mounted on a needle-valve-operated flow controller. Controller has an internal diaphragm assembly which gives a constant pressure differential for any valve setting. Indication of diaphragm failure is positive; integral rotameter instantly reflects diaphragm rupture or leakage. Rotameter/controllers are available in

Take a close look at this new limit switch! It's so immune to moisture, we'll guarantee it, electrically and mechanically, for one year or 10,000,000 operations . . . whichever comes first. We call it our Super-Sealed SL2-T. If you've ever had limit switch trouble caused by water, soluble oils, condensate or *any* kind of moisture, you'll want complete details. Call, write or wire.

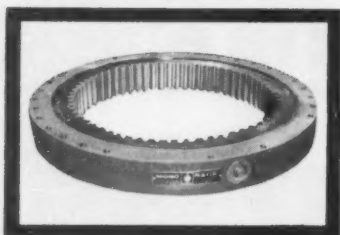
National Acme

THE NATIONAL
ACME COMPANY
188 E. 131st STREET
CLEVELAND 8, OHIO

Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.



USE RINGS IN YOUR PRODUCT?



Amweld flash butt-welded rings can cut your costs!

Amweld flash butt-welded rings are today lowering costs on gear blanks, bearing races, frame rings. Also rings for OEM, such applications as jet aircraft engines, missiles, and scores of other applications. Savings to Amweld customers totaled over one million dollars last year alone!

Here's your opportunity to reduce the cost of your circular components and assemblies. Amweld's close-tolerance fabrication of flash butt-welded rings cuts waste of materials, cuts out unnecessary machining. And Amweld's ability to

flash weld materials to Aeronautical Material Specifications offers proof of Amweld quality.

Investigate now! To see how Thew Shovel Company makes profitable use of Amweld flash butt-welded rings, mail coupon below for your free copy of Application Study R-1. Then let your Amweld representative show you how much flash butt-welded rings can cut the cost of your circular components!



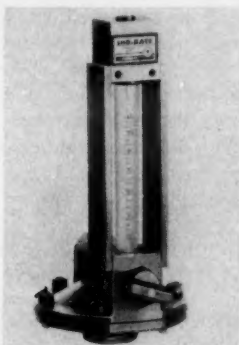
The American Welding & Manufacturing Co.
905 Dietz Road, Warren, Ohio

Yes, send Mono-Race Application Study along with full details on Amweld flash butt-welded rings as a cost reduction opportunity.



Name & Title _____
Company _____
Address _____
City _____
State _____

Amweld supplies flash butt-welded rings for the races of "Mono-Race" connections, designed and manufactured by The Thew Shovel Company's Mono-Race Division, Lorain, Ohio. This 10 ton hydraulic crane, manufactured by Grove Manufacturing Company, Pennsylvania, is a typical application of a Mono-Race connection.



several sizes ranging in flow capacities from 0.01 gph (water) or 0.2 scfh (air) to 12 gpm or 48 scfm. Pressure rating is 250 psig for brass models and 500 psig for Type 316 stainless-steel units. Brooks Instrument Co. Inc., Hatfield, Pa.

Circle 577 on Page 19

Wire-Reinforced Vinyl Hose

in $\frac{3}{4}$ to 12 in. ID

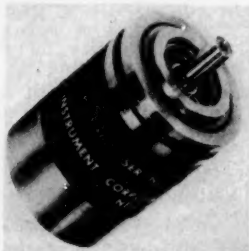
Flexvin is a wire-reinforced vinyl hose with high strength, flexibility, corrosion resistance, and resistance to abrasion. Available in ID sizes from $\frac{3}{4}$ to 12 in., it has many applications. Any length is furnished. Hose is offered in crystal clear, and tinted translucent or opaque in any color. Standard, nontoxic, and low-temperature formulations are available. Hungerford Plastics Corp., P. O. Box 376E, Morristown, N. J.

Circle 578 on Page 19

Synchronous Motor

has speed of 8000 rpm
with 400 cps input

New $\frac{3}{4}$ -in. diam, Size 8 synchronous motor, for use in computer systems, camera drives, scanning devices, and other missile/avionics applications, can be supplied with or without an integral gear box. Subminiature, 400-cycle unit is

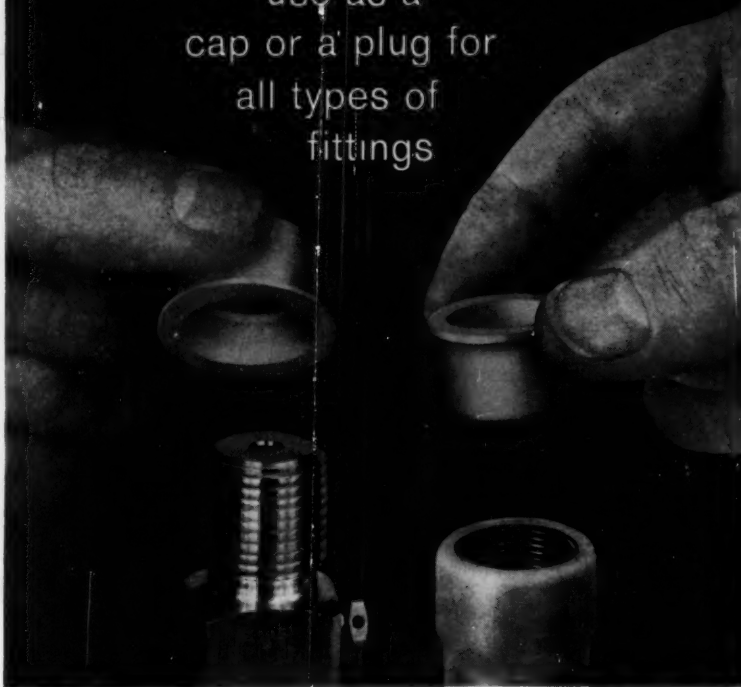


July 20, 1961

NEW S.S. White

GENERAL^{GP} PURPOSE PROTECTORS

use as a
cap or a plug for
all types of
fittings



Eliminate special sizes...fit more accurately!

S. S. White General Purpose "GP" Plastic Protectors are an improved way to protect your products during manufacturing, shipping and storage.

Each GP protector can be used as either a cap or a plug on all machine screw threads, pipe threads, and tubing in a range from $\frac{1}{4}$ " to $2\frac{1}{4}$ "...with an accurate, *engineered* fit. GP protectors eliminate special sizes and fit better!

"GP" protectors are made of a special grade of elastic polyethylene that cushions shock and is unaffected by oils, greases, acids and other common solvents. They have a "stay-put" fit, yet they are easy to grip for a quick, *non-shredding* removal.

Start now to *put an end* to customer complaints about damaged equipment. Use low cost GP protectors!

WRITE FOR BULLETIN 6104-GP

Complete details

1117

S.S. White PLASTICS
DIVISION

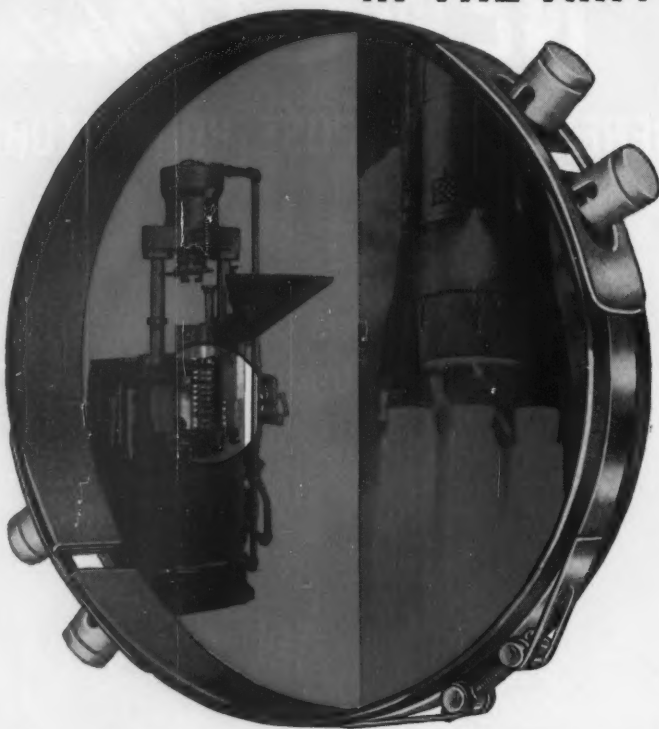
Dept. 4P, 10 East 40th Street, New York 16, N. Y.



Circle 348 on Page 19

225

ON THE GROUND... IN THE AIR...



you can rely on WATLOW NARROW-BAND HEATERS!

ON THE GROUND—Watlow Narrow-Band Units heat plastic in molding machines. They fit tighter due to the exclusive Watlow clamping band of non-expanding metal—and the tighter fit means better heat transfer. Dependable, long life and fewer burn-outs make Watlow the name to rely on.

Other applications include the heating of stamping dies, or other cylindrical objects.

IN THE AIR—A Watlow Narrow-Band heater of special design is launched with the missile. Its job—to keep the gear box on the LOX pump warm and operable when the liquid oxygen, at -200° , is pumped aboard. Only the most dependable heater made can be used in this situation—and WATLOW makes it.

WHAT'S YOUR HEATING PROBLEM?

New products—new applications often present unique problems in heating. Watlow specializes in custom designed heating units and will help you solve such problems.

OTHER PRODUCTS: Firerod Cartridge Units, Standard Cartridge Heaters, Tubular and Immersion Heaters, Strip Heaters, Hot Plates, Thermostats. Write for Watlow Catalog.

• Deliveries two weeks or less.



WATLOW

ELECTRIC MANUFACTURING COMPANY

1384 Ferguson Avenue / St. Louis 14, Missouri

NEW PARTS AND MATERIALS

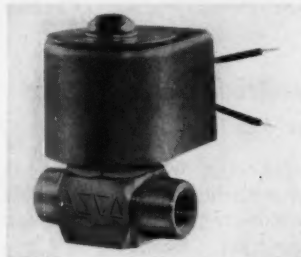
0.960 in. long, ungeared, and 2 5/32 in. long, geared. It features a synchronous speed of 8000 rpm with a 400 cps input. Gear-box ratios can be supplied from 5:1 to 20,000:1. Kollsman Motor Corp., Dublin, Pa.

Circle 579 on Page 19

Solenoid Valve

for cryogenic gases
and liquids

Midget, packless-type, two-way solenoid valve controls flow of cryogenic liquids and gases from -100° F to temperatures approaching absolute zero. It is supplied in either brass or stainless steel with Teflon



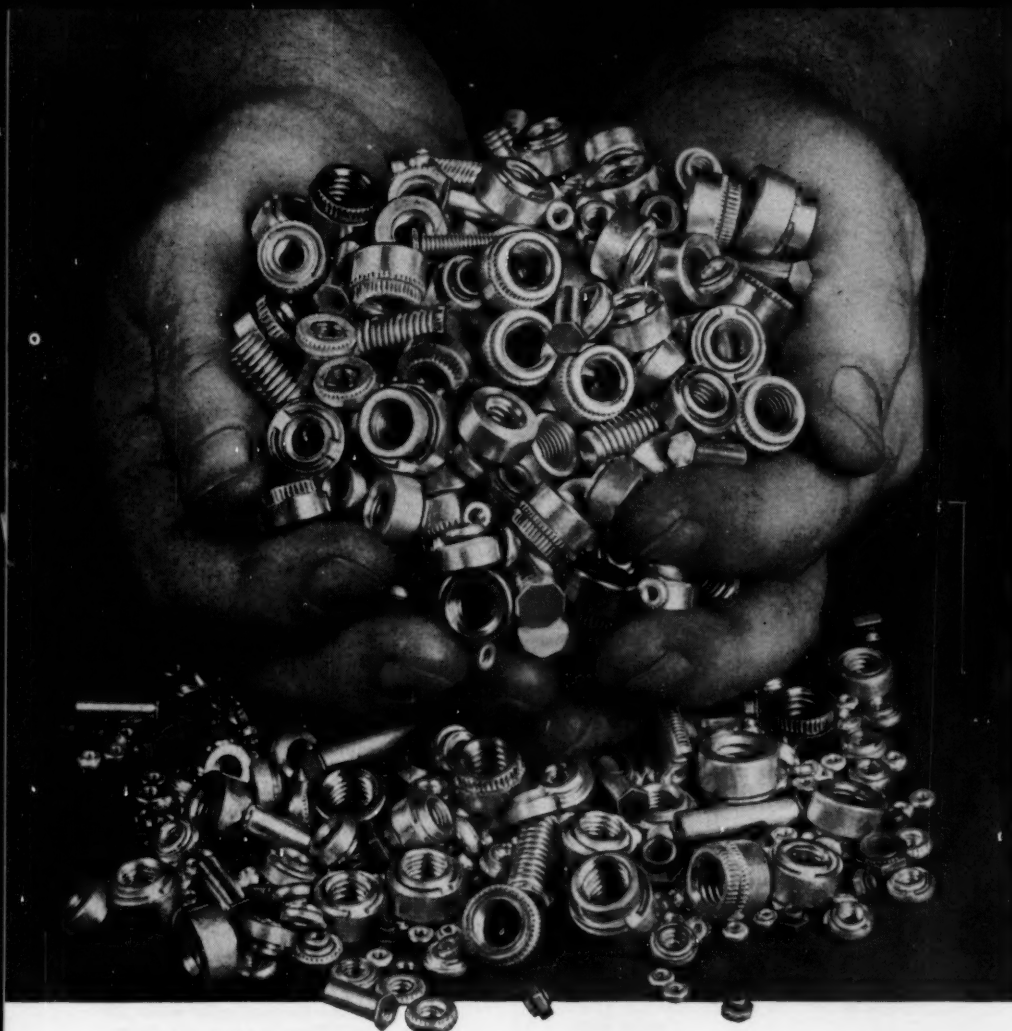
discs and gaskets for 1/4 or 1/8-in. pipe sizes. Valve can be mounted in any position. Automatic Switch Co., Florham Park, N. J.

Circle 580 on Page 19

Polyurethane Foams

have open-pore structure

Industrial foams of polyurethane are composed of a three-dimensional network of interconnecting strands. Wide range of standard pore sizes is available. Density is not related to pore size, and is constant over the entire range of 10 to 80 pores per linear inch. Foam is not adversely affected by water, soap, detergents, body acids, or perspiration. It can be safely dry-cleaned as it is not affected chemically by oils, solvents, or greases at normal temperatures. Foam has been used at temperatures to 250 F and can be sterilized with boiling water or steam. Foam stiffens somewhat at low temperatures but at -50° F it shows no tendency toward embrittlement. It can be shaped readily by saws or knives, by shearing, die-cutting, or hot-wire



Pay for themselves...*PLUS A PROFIT...* from Production Fastening Savings

Here is the means of cutting your costs in fastening sheet metal "too-thin-to-thread."

PEM self-clinching Fasteners—for every conceivable need—can serve 95% of your requirements. Can save more than that in use.

They are simply "clinched with a squeeze with the greatest of ease" to secure them into previously prepared holes.

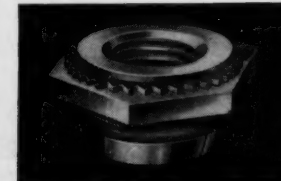
There are standard self-clinching nuts; midgets of the same design; self-locking, self-clinching nuts; self-clinching flush fasteners; self-clinching captive studs; self-clinching floating nuts; self-clinching stand-offs and self-clinching spline fasteners—size, type, metal, finish, we have them all! Open your mind and your specifications to this unexcelled line of captive threads for production fastening.

You will be surprised at their economy and the added product quality they provide.

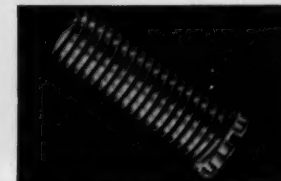


Circle 350 on Page 19

▶ SELF-CLINCHING
FASTENER



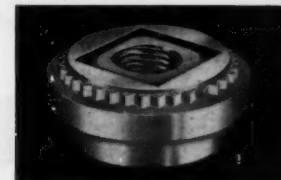
▶ SELF-CLINCHING
SELF-LOCKING NUT



▶ SELF-CLINCHING
CAPTIVE STUD



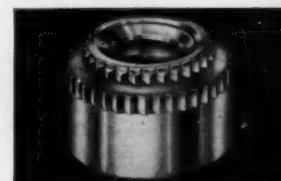
▶ SELF-CLINCHING
FLUSH FASTENER



▶ SELF-CLINCHING
FLOATING NUT



▶ SELF-CLINCHING
STAND-OFF



▶ SELF-CLINCHING
SPLINE FASTENER

PENN ENGINEERING & MANUFACTURING CORP.

DOYLESTOWN • PENNSYLVANIA

NEW YORK/BELLE HARBOR, L.I.—NEPTUNE 4-7103
CINCINNATI—GRANDVIEW 1-9011
CHICAGO (DOWNERS GROVE, ILL.)—WOODLAND 9-7770
MIAMI (SPYRADIO, INC.)—NATIONAL 1-0556
MONTREAL—REGENCY 1-0502

INDIANAPOLIS—CLIFFORD 1-4020
DENVER—DUDLEY 8-4644
DETROIT—UNIVERSITY 3-5189
TOLEDO—GREENWOOD 4-9553
TORONTO—BELMONT 3-2151

MILWAUKEE—BLUEMOUND 8-5118
MINNEAPOLIS—GREENWOOD 4-6203
DALLAS—FLEETWOOD 7-5713
LOS ANGELES—BRADSHAW 2-8097
SAN FRANCISCO (PALO ALTO)—DAVENPORT 1-8430

THE FREE MOLDING DIMENSION



... saves 35 machining operations

This target revolver barrel is now being made by the new Hitchiner Ceramic Shell technique of investment casting. *Thirty-five* machining operations are eliminated! The only external finishing required is partial polishing.

Investment casting may provide many benefits for you... choice of alloy... flexibility of design... improved parts performance... reduction of costs. Maybe one of your parts can be made better for less.

Write for
complete
technical
and facilities
information.



HITCHINER
Milford 3, New Hampshire

Circle 351 on Page 19

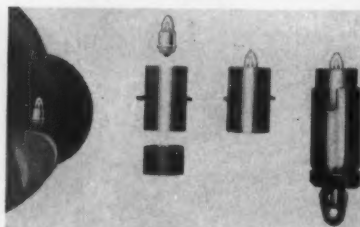
NEW PARTS AND MATERIALS

cutting devices. It can be nailed, stapled, sewn, glued, laminated, or taped to itself or other materials. Foam Div., Scott Paper Co., Chester, Pa.

Circle 581 on Page 19

Lamp Adapter

for T-1 ultraminiature incandescent lamps



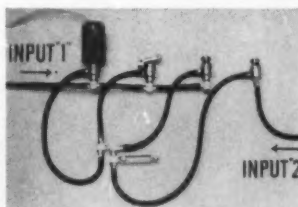
New lamp adapter for T-1 ultraminiature incandescent lamps fits any standard miniature bayonet-base socket. It provides a fast, easy method of mounting and using the lamp. Adapter is available with or without the lamp. Industrial Electronic Engineers Inc., 5528 Vine-land Ave., North Hollywood, Calif.

Circle 582 on Page 19

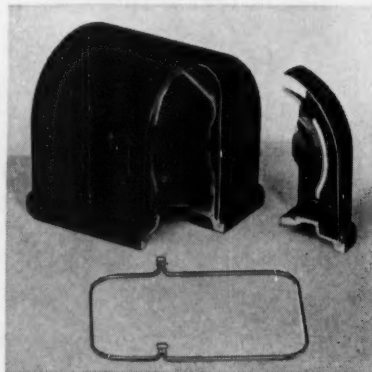
Miniature Shuttle Valve

incorporates sliding piston and Buna-N seals

Miniature shuttle valve, $\frac{3}{4}$ in. over-all in size, is for use in multiple fluid-power circuitry of cylinders, controls, and safety devices. Alternate flow from two inputs to a single output, but never to another input, is accomplished through the use of a sliding piston with Buna-N seals. Exhaust is always through the input port where pressure was last applied. Photograph shows how any number of shuttle valves can be joined together to actuate one cylinder, with valves controlled by solenoids, cam followers, or manual pushbuttons from one pressure source or different pressure



here's an idea...



use

metal-shielded wire

... a seamless metal tube drawn over insulated wire. The solid tubing eliminates stray leakage and protects insulation against mechanical damage and corrosion.

Minneapolis-Honeywell's Aeronautical Division uses Uniform's "Metal-Shielded Wire" as heating elements in their gyroscopes for rocket and missile guidance. As shown above, the wire is formed into a loop and imbedded in a lip at the base of the gyroscope case. Molten metal poured into the lip hermetically seals the gyroscope. There is never any danger of molten metal destroying the "Metal-Shielded" insulation, and the case can be opened or resealed in 30 seconds by simply passing a current through the wire.

Uniform's "Metal-Shielded Wire" is available in most metals including such highly resistant alloys as Nichrome V* or Tophet A**. Conductors may be multiple or single-strand wires with any type of desired insulation including plastic, rubber or heat-resistant glass braid. "Metal-Shielded Wire" is also made as composite tubing of multiple layers with each tube of a different metal to serve as resistance element, shield, or conductor.

With O.D.'s ranging from 0.010" to 0.375" and wall thicknesses ranging from 0.050" down to the ultra-thin 0.0015", "Metal-Shielded Wire" is available in random straight lengths or coils up to 30 ft. Wire can also be bent to desired configurations at the mill. Ends are cut and stripped, and all work is completed to close tolerances. Write for details today.

*Trade name of Driver-Harris Co.
**Trade name of Wilbur B. Driver Co.



**UNIFORM TUBES,
INC.** COLLEGEVILLE 2, PA.

HUXley 9-7276 TWX-CGVL 1044

Circle 352 on Page 19

Eastern



**INDUSTRIAL
CENTRIFUGAL
PUMPS**

**BULLETIN
NO. 130**



solve the processing puzzle WITH EASTERN CENTRIFUGAL PUMPS

In every detail of size, weight, space requirements, materials, power and costs, Eastern Centrifugal Pumps are made to match strict process requirements.

- **PRESSURES:** to 21 psi in single stage pumps; to 70 psi in multi-stage types
- **FLows:** capacities to 70 gpm in single-stage pumps, to 10 gpm for many multi-stage models
- **MOTORS:** standard motors for 115/230-volts 60 cycles 1 phase (other electrical characteristics available). Power range from $\frac{1}{8}$ to $1\frac{1}{2}$ H.P.
- **ENCLOSURES:** drip-proof, totally enclosed, and explosion-proof ball-bearing frames
- **DRIVES:** all models available in belt or coupling drive with ball-bearing equipped stands. Space-saving close-coupled pumps most rugged and popular — but many pedestal models also available
- **SEALS:** a variety of rotary seals and stuffing boxes, to fit every application
- **METALS:** your option of cast iron, bronze, stainless steel (18-8 type 303 and 316) Monel, Cast Iron, Hastelloy "C"
- **INSTALLATIONS:** a wide range of transfer, recirculation, feed, boost, and filter-pumping applications

TO FIND OUT: write for the brand-new Centrifugal Pump Catalog — Bulletin 130. Here are all the models — including useful engineering data.

For a complete review of positive displacement pumps for non-lubricating fluids, write for Bulletin 220. Eastern Bulletin 400 is your guide to a broad line of midget-centrifugal pumps and stirrers for the laboratory.



EASTERN INDUSTRIES, INCORPORATED

100 SKIFF STREET • HAMDEN, CONNECTICUT
West Coast Office: 4203 Spencer St. • Torrance, Calif.

Other Eastern products:

- hydraulic motors
- gear pumps
- positive displacement pumps
- aircraft pumps

Circle 353 on Page 19

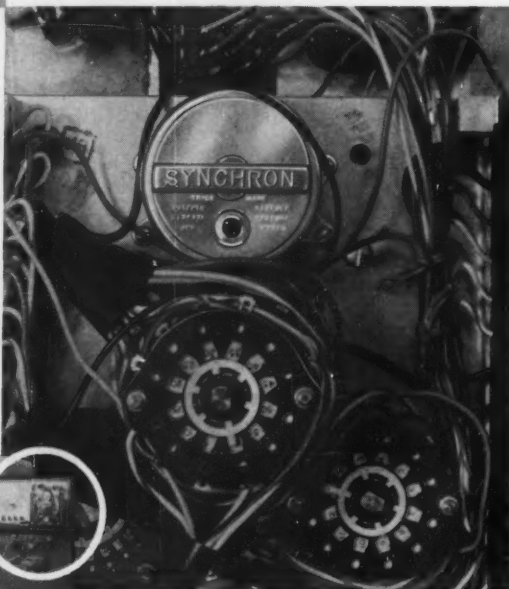


PRODUCT APPLICATION

**HANSEN
SYNCHRON
TIMING MOTORS**

*Hansen
SYNCHRON
motors,
the "heart"
controlling
the split-second
timing of
Schulmerich
Carillonic
Bells*

Schulmerich electro-mechanical **CARILLONIC BELL** systems...



SCHULMERICH CARILLONS, INC., world's largest manufacturer of electro-mechanical carillons, uses Hansen SYNCHRON Timing Motors to drive the program clock governing the all-automatic operation of these precision, perfect-tone instruments. Clock programming is offered at 15-minute intervals, 24 hours a day, 7 days a week. Scheduled to play at specified times, exactly to the minute — there is no allowance for plus or minus variation.

HANSEN SYNCHRON TIMING MOTORS were selected as an integral part of Schulmerich Carillonic Bells because they outperformed all other motors tested. Carefully controlled testing was based on four specifications: (1) instantaneous starting, (2) no time loss or gain, (3) absence of malfunction, and, (4) reliable, continuous operation for periods of a year or more. Depending on installation, motors operate at either 110 or 220 volts — 50 or 60 cycles.

SEND TODAY for informative folder containing specifications and technical data on all Hansen SYNCHRON motors and clock movements.



HANSEN REPRESENTATIVES:
THE FROMM COMPANY
5150 W. Madison, Chicago, Illinois
H. C. JOHNSON AGENCIES, INC.
Rochester, N. Y. — Buffalo, N. Y. — Syracuse, N. Y.
Binghamton, N. Y. — Schenectady, N. Y.
ELECTRIC MOTOR ENGINEERING, INC.
Los Angeles, Calif. — (Olive 1-3220)
Oakland, California
WINSLOW ELECTRIC CO.
New York, N.Y. — Essex, Conn. (SOuth 7-8229)
Philadelphia, Penn. — Cleveland, Ohio

Sweet's Product
Design File



NEW PARTS AND MATERIALS

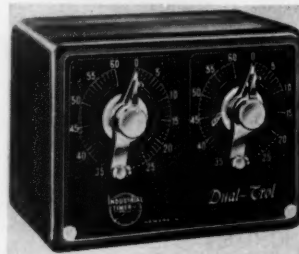
sources. Ports are tapped for 10-32 fittings. Recommended working range is 0.5 to 250 psi, and air flow rate is 5 gfm at 50 psi. Clippard Instrument Laboratory Inc., 7390 Colerain Rd., Cincinnati 39, Ohio.

Circle 583 on Page 19

Recycling Timer

has interchangeable
timing elements

Series Dual-Trol is a small recycling timer available with interchangeable timing elements. Timer produces a series of "on" and "off" electrical pulses which can be used to start and stop a process in a predetermined sequence. Time interval of both signals is easily changed by adjusting the timing knobs on the



face of the two timing modules. With any two timing modules, duration of either the "on" or "off" interval can be adjusted within a wide range. Wider range of time intervals can be obtained by inserting different timing modules. Total of ten timing modules is available with the unit, with maximum time ranges extending from 6 sec to 3 hr. Timer is operable on either 115 or 230 at 50 or 60 cycles. Industrial Timer Corp., 1407 McCarter Highway, Newark 4, N. J.

Circle 584 on Page 19

Disc Brake

eliminates or minimizes
alignment problems

Series 55,200 disc-brake unit offers a floor-mounted, through-shaft brake with its own ball-bearing-mounted shaft. Intended primarily for applications where it is necessary to drive through the brake, model eliminates or minimizes alignment problems. The ac-operated unit is available in torque

JOY ENGINEERS CAN DESIGN A FAN TO FIT...

ANY SPACE ANY DUTY

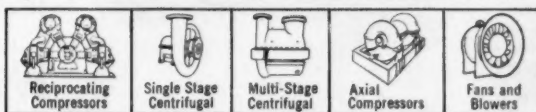
In many cases the primary requirement for cooling or ventilating fans is that they fit into whatever space remains after the major equipment components have been positioned. Length, width, height, weight . . . any one or all may be critical.

Joy engineers have developed hundreds of fans to meet specific dimensional requirements while delivering air at the required pressure and volume. Performance may be achieved with centrifugal, axial-flow, or mixed-flow designs, providing either

fixed duty point or broad operating range performance characteristics. Depending upon application requirements, basic construction may be either cast or sheet metal type fabrication.

Whenever you have an air moving problem, consult your Joy representative. Most requirements can be met economically from the hundreds of stock models available. If a special fan is necessary, Joy will provide an efficient, economical design. For full details on Joy fans, write for Bulletin 2555-64B.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company
(Canada) Limited, Galt, Ontario

IF you manufacture:

air conditioning
appliances
electronics
communications
electrical
apparatus
fans
blowers

machine tools
materials handling
panelboards and
switch boards
prime movers
pumps
compressors
general machinery

these Westinghouse products are tailored for you

On these pages are shown some of the many components developed and manufactured by Westinghouse specifically for OEMs. Here is one single source for technical assistance, manufacturing and stocking of all of your electrical needs. Use this *total* service to solve your design and manufacturing problems now. Call your local Westinghouse Sales Engineer or write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

J-96163-R

Westinghouse 

NEW



AB-I breakers

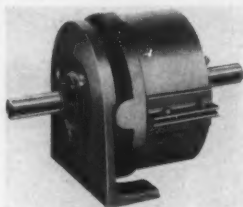
Often cost less than safety switches yet are better, smaller, lighter. AB-I Breakers for motor circuit protection are installed faster, approximately half the size, 1/3 the weight. Machine operator can "re-set" and contacts can be visible. Write for Bulletin B-7350 and be convinced—Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

J-96164

Westinghouse 

Circle 357 on Page 19

NEW PARTS AND MATERIALS



ratings of 1 1/2, 3, 6, 9, 10, and 15 lb.-ft. Stearns Electric Corp., 120 N. Broadway, Milwaukee 2, Wis.

Circle 585 on Page 19

Beryllium-Copper Strip

has high tensile strength and formability

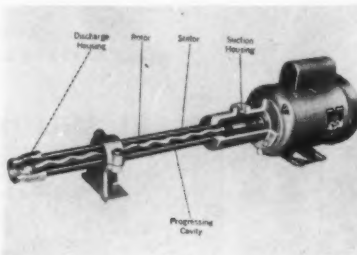
Mill heat-treated, beryllium-copper strip, Brush 190, has tensile strength to 190,000 psi and formability exceeding previous standards for this type of alloy product. Processes which harden the strip also provide a high degree of flatness and provide better uniformity throughout a coil and between lots. Material has high strength and dimensional stability coupled with good electrical conductivity and corrosion resistance. Brush Beryllium Co., 5209 Euclid Ave., Cleveland 3, Ohio.

Circle 586 on Page 19

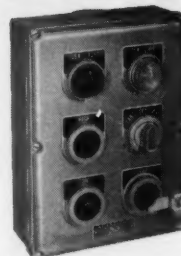
Motor-Driven Pumps

in ratings from 1/3 to 2 hp

Type SRM motor-driven pumps in 13 sizes are available with capacities to 26 gpm in ratings from 1/3 to 2 hp. All sizes deliver discharge pressures of 100 psig, five go up to 200, and one to 350 psig. Over-all length of the units ranges from about 22 to 45 in., and maximum height is 9 in. Design of the pump—a screw-like rotor turning within a fixed stator—eliminates pistons, valves, and high-speed impellers to provide long service life, uniform



NEW



Oil-Tite pushbuttons

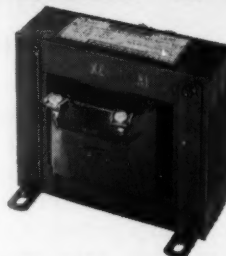
Simple, rugged, contamination-proof. Flush oil-tite pushbuttons with minimum projection keep oil, coolant, cutting oil or water from contacts. Wide variety of head types and interchangeable color caps make this one of the most flexible lines of pushbuttons available today. Write for Bulletin B-7321, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

J-96166

Westinghouse 

Circle 358 on Page 19

NEW



Black Line Control transformers

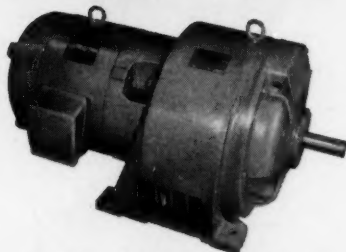
Especially designed for machine tool control. Compact design plus Westinghouse's exclusive "BONDAR" Class "A" insulation combines quality and minimum space in Black Line Transformers. Offered in a wide range of voltage ratings—.025 kva through 5 kva with a 55° C. rise. For details, write for Bulletin B-7879 to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

J-96170

Westinghouse 

Circle 359 on Page 19


NEW



Magnaflow electro-magnetic drives

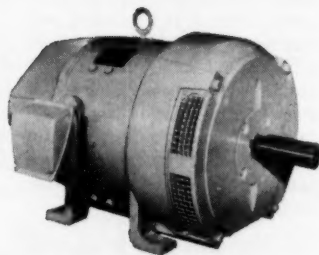
Economy, less space, 17:1 speed range or more. Includes everything needed for stepless wide-range speed control from a-c power. Has a-c motor drive, electromagnetic coupling, regulating exciter, operator control station plus variety of modifications to suit special operating conditions (1/4 to 700 hp). Write for B-7875, Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96167

Westinghouse 

Circle 360 on Page 19


NEW



TEFC d-c motor

For fastest d-c motor response! New totally-enclosed, fan-cooled Life-Line H d-c motor with 75% less armature inertia, 500% commutating ability for acceleration results in faster stops, quicker stops, faster reversing. 30 hp rating accelerates from 0 to 1750 rpm—fully loaded—in 1.1 sec.; similar response in ratings 1 to 75 hp and higher. Write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96168

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Circle 361 on Page 19

NEW PARTS AND MATERIALS

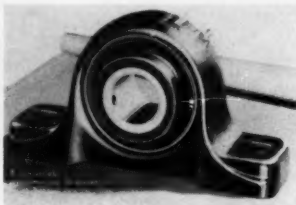
flow, low internal velocity, positive displacement, and self-priming operation. Standard construction: Rotors of Type 416 stainless steel, stators of synthetic rubber, and housings of cast iron, cast aluminum, or cast stainless steel. **Moyno Pump Div., Robbins & Myers Inc., Springfield, Ohio.**

Circle 587 on Page 19

Pillow Blocks

in 5/8 to 4-in. shaft sizes

Series P2-300 heavy-duty, ball-bearing pillow blocks are equipped with self-aligning, single-row, deep-groove, precision ball bearings which conform to basic standards of the AFBMA. Complete range of shaft



sizes from 5/8 to 4 in. is available. Heavy-duty blocks have dimensional interchangeability with other makes. **Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.**

Circle 588 on Page 19

Subminiature Indicator Lights

mount in 15/32-in. clearance hole

Subminiature indicator lights are completely watertight on the face of the panel; two O-ring seals are used. Each unit measures 1 3/16 in. over-all length and mounts in a single 15/32-in. clearance hole. Socket, lamp, and all connections are insulated from the mounting bushing by means of phenolic material. Eccentric shape of terminal-location washer enables it to be tightly engaged and locked by the flared-over edges of the notched bushing, preventing rotation of the lens cap and internal components of the assembly. Units accommodate T-1 3/4-in. midget, from 1.3 to 28.0 v. Lights are designated 177-8430-971. **Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.**

Circle 589 on Page 19

NEW



AVR adjustable speed drives

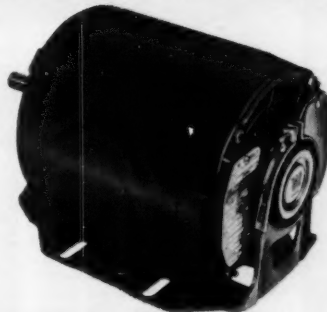
Static design, less floor space, easy installation, flexible. System converts a-c to d-c to operate an adjustable speed d-c motor. Includes a power unit, main d-c drive motor and operator's control station. Available from 1 to 200 hp or larger. Write for Bulletin 5601 to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96172

Westinghouse 

Circle 362 on Page 19


MOTORS



fractional hp

Operates 25,000 hours without re-oiling on light duty applications, uses specially designed sleeve bearing lubrication system. Over 550 motor styles rated 1/8 to 1 hp in variety of combinations of mechanical features are stocked by Westinghouse at all times to meet your instant needs. Write for Bulletins 2820 and 2850 to Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96173

Westinghouse 


Circle 363 on Page 19

EVERY TYPE OF KEYING AND PINNING DEVICE FOR PRODUCTION ASSEMBLING

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PIVOTS

SHAFTS & PINS



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exacting needs
of exacting
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Gillen instrument pivots are precision-machined from high grade carbon tool steel, heat treated for glass-hard bearing points, highly polished and ready for assembly.

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PIVOTS • TENSION, TAPER, GROOVE & DOWEL PINS • MACHINE KEYS & PARTS

Circle 364 on Page 19

ENGINEERING DEPARTMENT **EQUIPMENT**

Light Magnifiers

with one or two
extension arms

Two models of a clamp-type light magnifier provide cool, shadowfree light and undistorted magnification when directed over a working area. Magnifiers are equipped with 5-in. lens, providing ample working space within their focal range, and are illuminated with an 8-in. circular, 22-w fluorescent light. Models can



be mounted on tables, benches, machines, and walls. Model 100 features two extension arms, 24-in. reach, and 360-deg sweep; Model 104 has one extension arm and 38-in. reach. Both models feature fingertip control for ease of positioning. **Safety Dept., Boyer-Campbell Co., 801 W. Baltimore St., Detroit 2, Mich.**

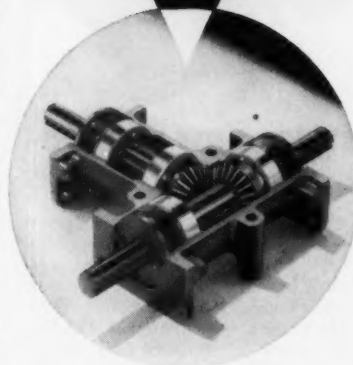
Circle 590 on Page 19

Tape Recorder

has speeds of 1.875,
3.75, 7.5, and 15 ips

Model TR-1875 miniature magnetic tape recorder simultaneously records data on 1 to 14 channels from tests conducted under severe environmental and limited space conditions. Recorder is available in speeds of 1.875, 3.75, 7.5, and 15 ips, with a capacity of 150 ft of 1-mil polyester instrumentation tape providing up to 16 min recording. Precision unit measures 4 1/4 in. diam and 4 3/4 in. long, and weighs less than 3 1/2 lb. Wow and

ANGLgear®
simplifies your
90° drive
problems



ANGLgear's hardened bevel gears and anti-friction bearings—exposed in the cutaway above—insure quiet, trouble-free operation. Being completely enclosed and permanently lubricated, unit requires virtually no maintenance.

Wherever you have a 90° power takeoff requirement in the 1/8 to 5 hp range, a standardized ANGLgear unit usually provides the simplest, most economical solution.

Compact, high-capacity ANGLgear offers you a number of advantages. Featuring universal mounting, it is easier to design into your power transmission systems; easier to install. Incorporating positive bevel gear drive, it eliminates slippage and minimizes backlash problems. Completely enclosed, it presents no safety hazard. Permanently lubricated, it requires little or no maintenance. And being standardized, ANGLgear is economically priced.

Standard ANGLgear is available from stock in 1/8, 1, 2 1/4 and 5 hp ratings, with a choice of 1:1 or 2:1 gear ratios and 2 or 3-way shafting. Send for Catalog IA-58 or contact our local distributor.

ENGINEERS: Write for free ANGLgear design templates.



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CORPORATION**
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Circle 365 on Page 19

low compression set good aging
 excellent bondability controlled stiffness
 excellent resistance to non-contaminating
 oxidation and ozone odorless
 excellent resistance to tasteless
 staining matched color
 excellent low broad temperature res.
 temperature built-in lubrication
 low permeability low shrink
 excellent fatigue high tensile strength
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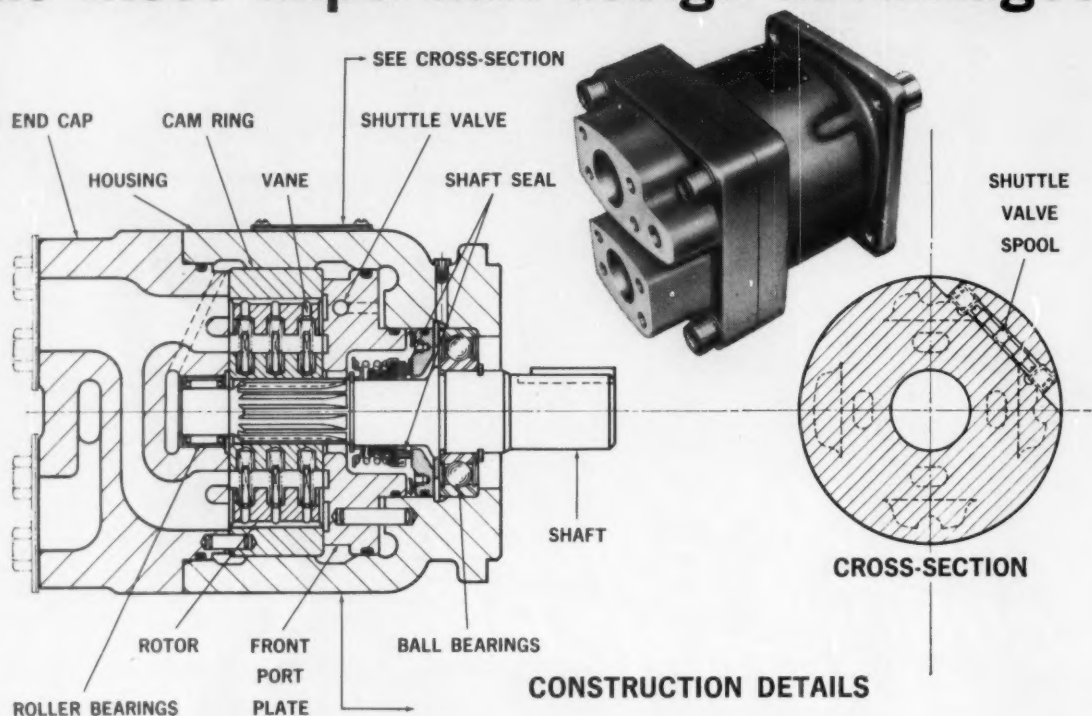
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"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PA.

FOR HYDRAULIC ROTATING POWER:

New 2000 psi balanced-vane fluid motor has these important design advantages



By: Robert A. Manogue

*Pumps/Controls Product Manager
Denison Engineering Division
American Brake Shoe Co.*

Today's demands for efficient, low cost hydrostatic power transmissions are growing rapidly. Design engineers have, in turn, demanded reliable vane-type fluid motors that are compact, lightweight and efficient for their hydraulic rotating power needs.

COMPACT 1 LB. PER HP RATIO

The new Denison "M1D" Series floating cartridge, balanced vane/balanced rotor fluid motor shown here is one of 5 sizes available. They are excellent choices for service up to 2000 psi at speeds up to 2000 rpm and for hp ranges up to 75. Unit size is a highly compact $11\frac{1}{16}$ " long by $6\frac{1}{8}$ " square—including normal keyed shaft extension. Weight is under 75 lbs., affording an efficient 1 lb. per horsepower ratio.

The five motor sizes offer a range of maximum theoretical torques of 1249, 1719, 1897, 2160 and 2345 lb.-in. at 2000 psi.

BALANCED VANES AND ROTOR

The pumping cartridge (vanes, rotor, cam ring, front and rear port plates) offers high efficiency power transmission

through the motor shaft by symmetrically balancing the rotor and vanes 100% for axial thrust in both directions. Radial vane balance is approximately 80%—imparting a 20% pressure loading to the vanes as outward force against the cam ring to allow following the cam contour. By a unique combination of spring loading and oil porting control, vanes are balanced outward during their entire pumping period. This balance is produced by a combination of centrifugal force, spring loading and partial pressure loading.

Denison's vane design (two contoured sealing lips) also means effective control of cross-port leakage during work stroke on the major cam ring diameter. This leakage is normally inherent in most other fluid motors.

SHUTTLE VALVE CONTROLS CARTRIDGE LOADING

Clamping forces are imparted to these new M1D fluid motors by a unique shuttle valve, interconnected with the motor's two external ports. This valve shifts automatically to maintain the highest pressure available to the front port plate in order to control motor cartridge clearance axially. This special design always ports highest pressure oil to the rear of the front port plate—providing controlled cartridge loading that gives peak effi-

ciencies and permits starting at any temperature.

FOUR OTHER DESIGN ADVANTAGES

Four other important features of the Denison M1D Series: (1) A 100 psi mechanical shaft seal. (2) Extremely wide bearing spacing to permit full shaft side loading—up to 795 lbs. side load. (3) Angular alignment is achieved by means of snug fit dowel pins. (4) Designed for SAE requirements—including 4-bolt SAE mounting pad, SAE spline shaft and SAE fluid connections. The main motor connections are $1\frac{1}{4}$ " SAE fluid pads. Drain connection is $\frac{1}{8}$ "—18 UNF2B thread for $\frac{3}{8}$ " tube size.

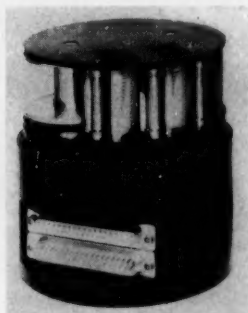
NEW SPECIFICATIONS BULLETIN FOR DESIGNERS AND ENGINEERS

Write for your copy of Bulletin FMV-1 on new Denison M1D Series Vane-Type Fluid Motors. Includes specifications, operating and application data, performance figures on this new 2000 psi equipment.



DENISON ENGINEERING DIVISION

American Brake Shoe Company
1240 Dublin Road • Columbus 16, Ohio



flutter under static conditions are less than 1 per cent. Aero Data Corp., Div., American Concertone Inc., 9449 W. Jefferson Blvd., Culver City, Calif.

Circle 591 on Page 19

Temperature Probe

for use in temperatures to 500 F

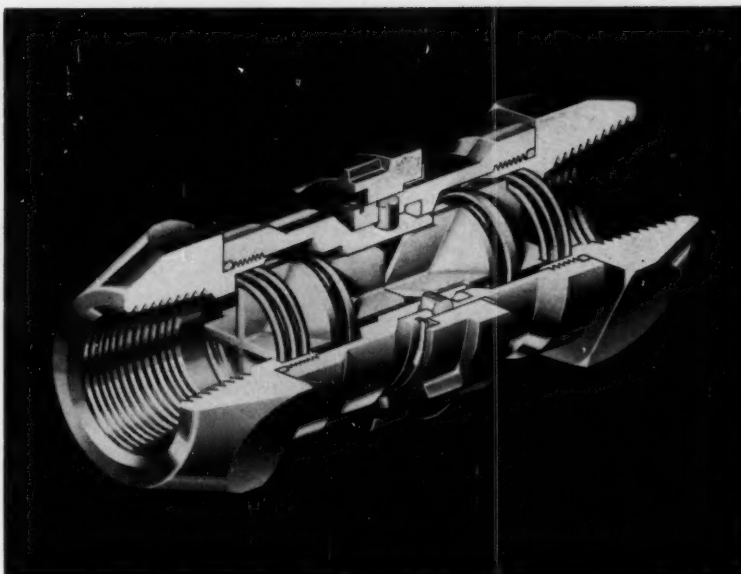
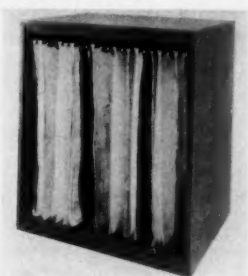
Type TD temperature probe provides accuracy of measurement in gases at velocities of 100 to 2000 fps and temperatures to 500 F. Thermocouple elements are furnished in iron-Constantan, copper-Constantan, and Chromel-Alumel wires. Element is coiled to expose maximum surface to the gas to eliminate conduction errors. United Sensor & Control Corp., P. O. Box 149, Glastonbury, Conn.

Circle 592 on Page 19

Steel Filing Cabinet

accommodates drawings up to 24 x 36 in.

Open-type steel filing cabinet for engineering drawings, blueprints, and maps is designated Stikfile Model OC-2224. Cabinet has 22 binders, each holding from 1 to 75 prints for a total capacity of 1650 prints. It accommodates prints up to 24 x 36 in. Cabinets uses ceiling-mounted traverse tracks for



ROTO LOCK® Industrial

... this exceptional quick-connect coupling is now available* for industrial fluid systems handling anything from air to molasses

These are the performance salients of ROTO LOCK:

- **high-pressure capability**—from special locking pins that divide psi evenly over the locking mechanism
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- **very low leakage**—from a fast-acting sealing mechanism that puts a firm, uniform squeeze on the O-rings
- **long service life**—from the maximum-contact locking pins that eliminate "brinelling" failure, common to ball-type designs
- **easy, fast operation**—one quick twist on locking collar to connect, one quick reverse twist to disconnect.

If you're looking for this type of performance, then ask for your free copy of the new ROTO LOCK Industrial Catalog, C-3001. It tells the complete design story and provides all the specifying data you'll need to fit ROTO LOCK to your exact requirements. A note on your letterhead will do the trick. Or, if you wish, just fill in the coupon below and mail.

*In standard sizes from 1/4" thru 3"; no size limits on special designs.



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SPECIFY WOOD'S ULTRA-V DRIVES

Wood's Ultra-V Drives offer tremendous savings over conventional v-belt drives . . . up to 50% in space, 27% in weight, 30% and more in costs. And there are savings on bearings, bases and housings. Greatly improved belt materials and belt construction assure unmatched dimensional stability, amazing strength, greater grip, added support and equalized load for tension members. High performance, Ultra-V sheaves have smaller diameters, less width, less weight and tremendous strength, are equipped with famous "Sure-Grip" Bushings.



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Circle 369 on Page 19

ENGINEERING DEPT. EQUIPMENT

hanging binders. Binder-screw heads provide the hanging device, sliding in and out of the traverse track. Top of the cabinet affords table space for reference purposes and working area. **Dancer Stikfile Co.**, P. O. Box 10221, Houston 18, Tex.

Circle 593 on Page 19

Table Whiteprinters

for engineering drawings

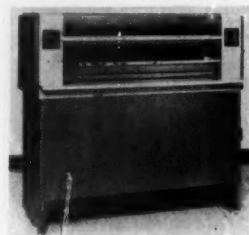


Table-top Rockette whiteprinters are offered in two new models. One has an exposure lamp of 40 w per in. (2000 w total) and a printing speed of 25 fpm; the other features a 60-w per in. lamp (3000 w total) with speeds of 35 fpm. Master and copies are returned to the operator via front receiving trays, and copies are stacked in sequence. Machines operate on 220-v, 60-cycle ac. **Paragon-Revolute Div., Charles Bruning Co. Inc.**, Mt. Prospect, Ill.

Circle 594 on Page 19

Temperature Chamber

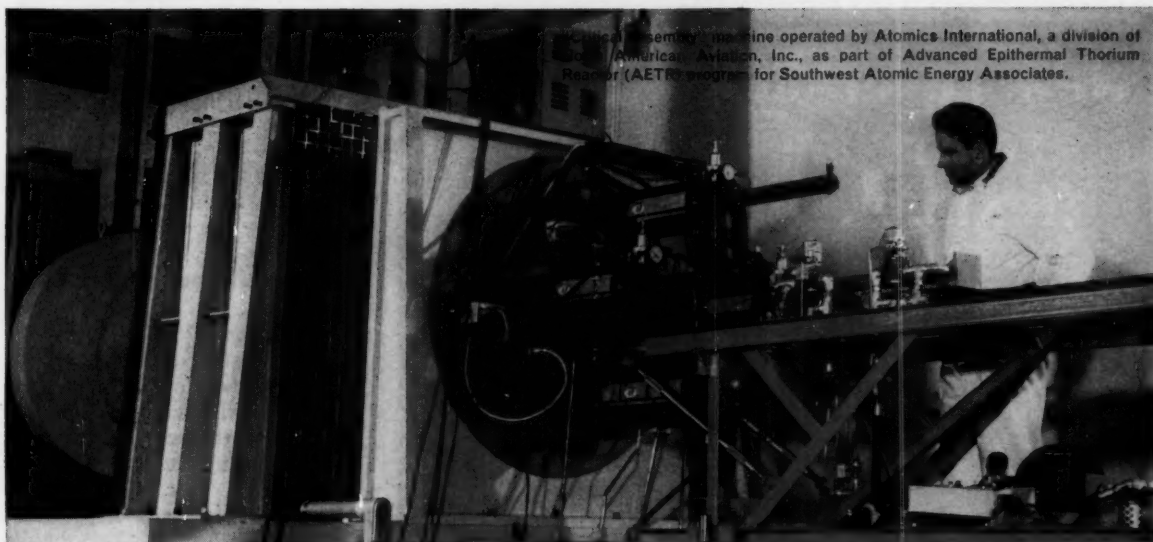
for temperatures from
-100 to +500 F



Model 1060F portable, table-top temperature chamber completes a cycle between -100 and +500 F in less than 12 min with control accuracy of ± 0.50 per cent. Test volume is 10 x 7 x 7 in. **Delta Design Inc.**, 3163 Adams Ave., San Diego 16, Calif.

Circle 595 on Page 19

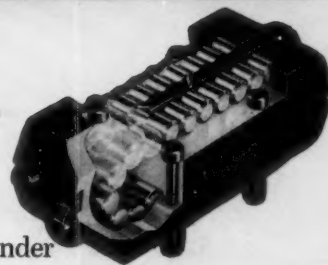
MACHINE DESIGN



"critical assembly" machine operated by Atomics International, a division of Aerojet American Aviation, Inc., as part of Advanced Epithermal Thorium Reactor (AETR) program for Southwest Atomic Energy Associates.

FRICION-FREE MOTION *adds precision, reproducibility to Atomics International "critical assembly" machine.*

The carriage on this machine must be positioned as accurately under a 50-ton load as under no load. Scully-Jones precision ball screws and Tychoway recirculating bearings help make this possible. Besides eliminating friction, bearings control vertical and horizontal alignment and allow reproducible closure conditions. Accuracy of the S-J ball screw on the closure drive makes possible direct digital readout of table position over a 5-foot travel — eliminates auxiliary positioning indicators. / Scully-Jones antifriction devices contribute important new design concepts — increase accuracy, economy, and service life . . . simplify lubrication and reduce power requirements. Write for Bulletins 22-50 and 25-50.

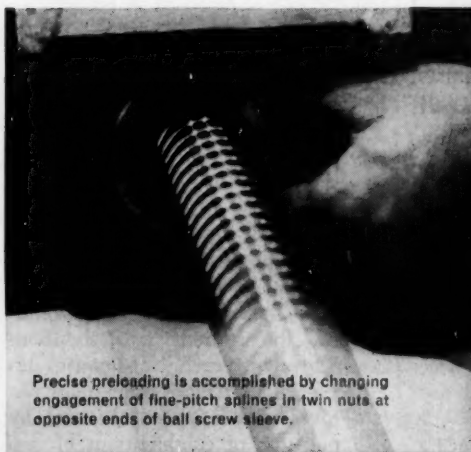


Special Products Division

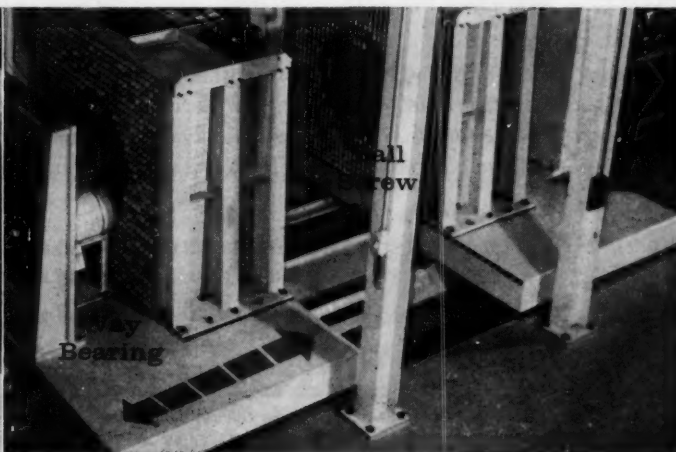
**SCULLY
JONES**

Scully-Jones and Company

1905 South Rockwell Street, Chicago 8, Illinois



Precise preloading is accomplished by changing engagement of fine-pitch splines in twin nuts at opposite ends of ball screw sleeve.



Tychoway Bearing

New reversible rotary air motors— flexible . . . fractional horsepower

Model 71B2R reversible
rotary air motor



Model 71E1R reversible
rotary air motor

Here are new *reversible* air motors that add flexibility to designs that require $\frac{1}{8}$ or $\frac{1}{4}$ hp built into a limited space or close quarters. Provide light weight and easy foot or flange mounting.

Other features that well may be important to your design include quick stops and starts . . . simple control . . . no possibility of motor burnouts . . . no spark hazard . . . continuous operation . . . rugged construction . . . built-in spindle bearings.

Contact your Gardner-Denver representative for a demonstration of new *packaged reversible power*—the new Series 71E1R and 71B2R air motors. Or write for No. 71 bulletins. Also available as nonreversible motors—part of the complete line of Gardner-Denver air motors from $\frac{1}{8}$ to 16 hp.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW



GARDNER DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

Professional Viewpoints

. . . four kinds of engineers . . .

To the Editor:

I read your "Four Kinds of Engineers" in the May 11, 1961, issue of *MACHINE DESIGN* with real interest. The answers you receive to your concluding question should be interesting.

The real significance of your editorial note lies in the fact that it directs attention to the weak links in engineering education, namely, lack of understanding of the definition of engineering and the engineering method.

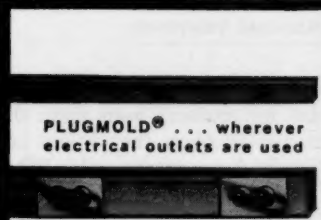
An answer to your question "which of these men promises to be the most effective engineer?" rests upon the criteria to be used as measures of effectiveness. Also, the professor's statement of the problem needs implementation if it is to be called an engineering problem in contrast to an exercise in heat transfer.

In the limited form in which the problem was stated the only result that could be expected from the students was a set of alternative methods for resolving the problem. Additional approaches could be added.

I would not agree that the modes of analysis proposed by the students should be interpreted to mean that there are four kinds of engineers. The key observation is that there are, as Deans Hawkins and Boelter brought out a few years ago in a joint paper on engineering analysis, four modes of analysis, namely:

1. Analytical
2. Experimental
3. Art or experience
4. Models and analogues

They emphasized that since each of these modes of analysis is the optimum choice under certain conditions, the student must be conversant with each. He must also recognize that more often than not a problem solution is obtained by application of combinations of two




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AIR DUCT ... moves air, fumes, particles, materials

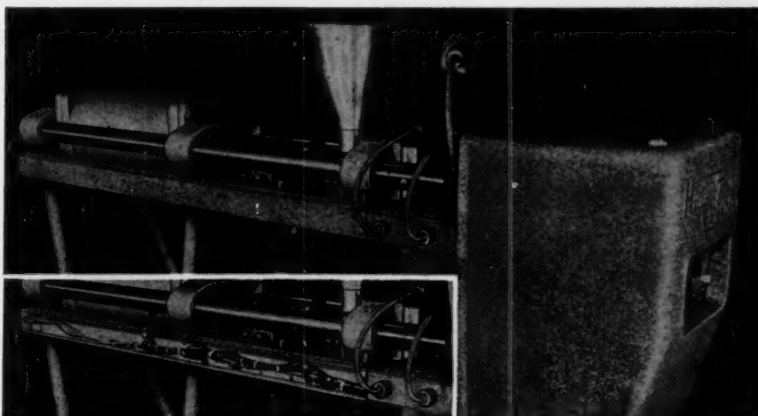
Machine has electrical raceway built in

Plugmold raceway places outlets conveniently; houses wiring systems and other devices

More and more standard units and variations of Plugmold multi-outlet systems are being built into original equipment — such as this Hull-Standard Model 99-A Molding Press (Hull Corp., Hatboro, Pa.). This press uses two lengths of Plugmold 3000 on the frame, one as a housing for the wiring system, the other for housing pipe lines.

Plugmold was easily adapted for this application. Holes were drilled for three switches and two indicators located on top of the run. Plug-in, plug-out convenience is provided for the heating coils; a work light is also included. Wiring is easy to get at, simply by removing the raceway cover (see photo inset).

In the same position on the opposite side of the press, Plugmold 3000 makes a neat housing for three pneumatic pipe lines from compressor to direction control valve.



Plugmold on molding press holds wiring for light, indicators, heating coils, and switching.

Wide choice for designers

Plugmold is made in a number of sizes, with almost unlimited choice of outlet types and spacings. Modifications of standard product engineered to meet specific or special requirements can be made; for example, factory-wired and assembled Plugmold incorporating circuit protective means on the channel (fuse or circuit breaker), portable power strips with provision for easy connect and disconnect, Plugmold wired with multi-prong jacks for control circuits, etc.

Wiremold welcomes the opportunity to assist in developing special Plugmold multi-outlet assemblies.

Designing with duct:

Unique construction has hidden values

When you are designing with flexible duct, look into the extra values of Wiremold's mechanical construction (see cutaway).

While Wiremold's six standard types meet most needs, the mechanical construction permits use of other fabrics and metals. This mechanical lock does not require adhesives, assuring long life.

The metal spiral, being flat, speeds your assembly line too. Close ID tolerances assure an easy, snug fit to connectors. In seconds, duct is fastened by securing 2 or 3 drill screws through the flat spiral and connector. There's no need for clamps — or cuffed ends — although cuffs are available for those applications where quick disconnect is needed. Special shapes (e.g., square, oval) can also be furnished.

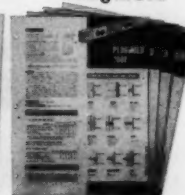


Unique mechanical construction — fabric is locked to flat metal spiral — has many advantages. For one, fast hook-ups to connectors with drill screws.

SEND FOR LITERATURE

Air Duct

Plugmold



For Air Duct data, ▲
Circle 372 on Page 19

For Plugmold data, ▲
Circle 373 on Page 19

Have you checked carbon & graphite?

S MANY

"MECHANICAL ADVANTAGES" LATELY?



for High Temperature Work—As bearings or seal rings, several specially-formulated Stackpole grades provide long life and low friction up to 1200°F—temperatures where more costly and exotic materials often fail.



for High-Speed, Unlubricated Uses—In terms of life, maximum speed, and low friction, Stackpole carbon & graphite offer many performance dividends over even more costly self-lubricating bearing and seal ring materials.



Handling Chemicals & Gases—Inert Stackpole carbon & graphite resist attack in all but the most highly oxidizing atmospheres at normal temperatures.



Under Thermal Shock—Stackpole carbon and graphite materials will not spall, crack, melt or seize in difficult refractory applications.

STACKPOLE

Stackpole Carbon Company, St. Marys, Pennsylvania

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PROFESSIONAL VIEWPOINTS

and more of the approaches.

Had my students been given the roast beef problem, they would immediately have asked: (1) What degree of accuracy is required (quality of answer), (2) how much money is available for making the study (cost), (3) when is the answer wanted (date), and (4) they would ask such auxiliary questions as pertain to oven construction, and is this a one-shot problem, or is there a long-range significance involved.

Having defined the problem, they would then proceed with a quick appraisal of the modes of analysis available to determine which would most appropriately meet the requirements established by the definition of the problem.

Your concluding question is inappropriate. A good case could be made for each of the approaches under specific conditions of quality of answer, money available, date required, and auxiliary factors. Any engineer who knows only one mode of analysis doesn't hold any promise for competitive industry.

Your editorial note, however, is of real service, since it directs attention to the need for thorough understanding of the different modes of analysis available to the engineer.

—EVERETT LAITALA, *Head*

*Dept. of Industrial Engineering
Clemson College
Clemson, S. C.*

To The Editor:

Your editorial, "Four Kinds of Engineers," is very instructive and amusing. Without attempting to answer your closing question, I should like to make some remarks.

1. The fourth student might have obtained the same, quick answer by consulting some standard handbook for culinary engineers, commonly called a cookbook.

2. I feel that all four students made a very meaningful error—an error which is made by far too many engineers and scientists today. Your four students apparently considered themselves as "slaves," duty bound to scurry about industriously attempting to solve any problem which happens to filter

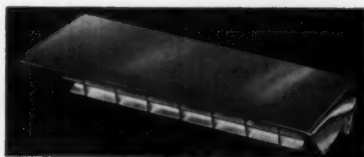
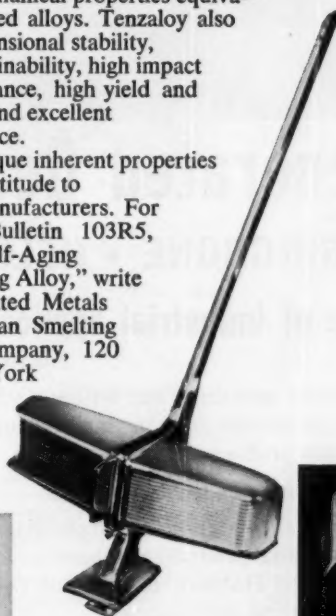
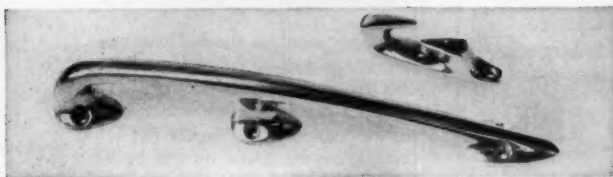
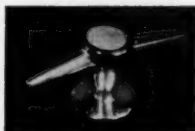
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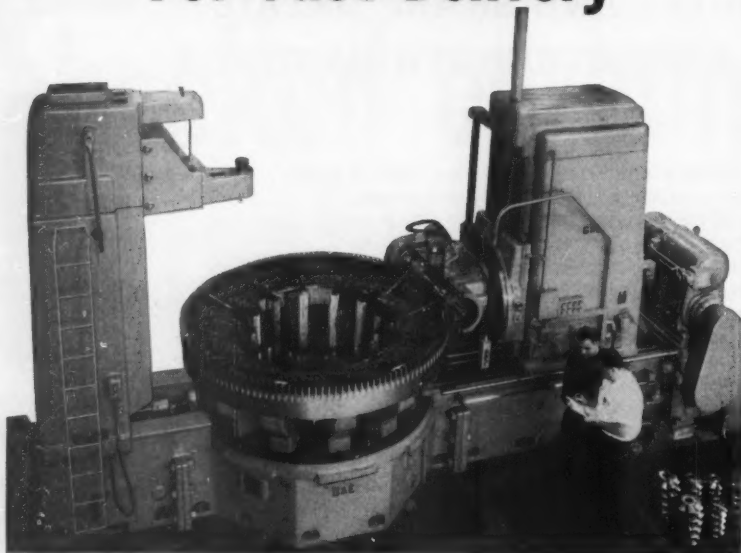
Tenzaloy's unique inherent properties offer wide, new latitude to designers and manufacturers. For your copy of Bulletin 103R5, "Tenzaloy, the Self-Aging Aluminum Casting Alloy," write today to: Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, N. Y.



Circle 375 on Page 19

TENZALOY

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PROFESSIONAL VIEWPOINTS

down to them from "management." I believe that engineers and scientists should consider themselves as professional people. I believe that they, as professional people, have a duty to society, to their employers, and to themselves to ask certain impertinent (?) questions with regard to problems which are given them. Among these questions are the following: "Who wants the solution to this problem?" "Why does he want it?" "What use will he make of the solution when he gets it?" The answers to these questions may reveal that the problem is meaningless, or that it is improperly stated, or that the solution to an entirely different problem is really what is needed. It seems to me that "management" will do their stockholders (and their nation) a big favor if they encourage engineers and scientists to ask such questions as these.

—A. W. SOLBRIG JR.

Argonne National Laboratory
Idaho Falls, Idaho

Another reader scrawled this comment across the bottom of the editorial page: "How many mothers do you think could answer such a question without experiment? The suggestion is lousy." And of course Professor Laitala is right in stating that the concluding question is inappropriate; no one approach is necessarily the most effective even for a single problem. Following Mr. Solbrig's reasoning, the student who is going to be an effective engineer would not overlook the fact that the professor is part of the problem. The one who consulted his mother might or might not get the correct answer, but he most certainly would not receive a passing grade on the problem if that had been his sole approach.

—ED.

They Say . . .

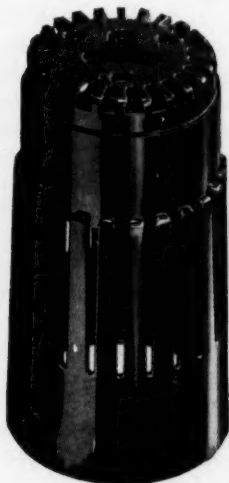
"Engineering is more than just learning about scientific matters; it is a way of life. In this technological age it is a discipline, as were the teachings of Aristotle, Socrates or Euclid, in their age."—O. S. CARLISS, Director of Engineering, Materials Handling Div., Yale and Towne Mfg. Co., Philadelphia, Pa.

PRODUCT-DESIGN BRIEFS FROM DUREZ

- Phenolic for wet-dry jobs
- Plastic in subway cars
- Structural adhesives

Are you in hot water?

This washing-machine component has three jobs to do. It filters out lint from the wash load, adds detergents and



PHILCO CORPORATION

bleach powders to the wash water, and dispenses clothes conditioner or water softener into the rinse water.

Design of the part clearly indicated molded plastic for economical production. But it was essential to have a plastic that would stand long exposure to moisture, heat, and detergents, and provide a good-looking surface.

That's why *Durez 13856 Black* was selected. This flock-filled phenolic molding compound is especially formulated for parts in contact with water. It's widely used in pumps and valves—particularly when a part is to be wet on the inside and dry on the other. It has excellent resistance to detergents, acids, soaps, mild alkalies, and many solvents. Hot, sudsy water can't harm it. In addition, the material has the inbuilt ruggedness and durability of all phenolics—and is relatively low in cost per lb.

Light—and tough

Philadelphia expects to save \$6.5 million over the 35-year life span of its 270 new subway cars.

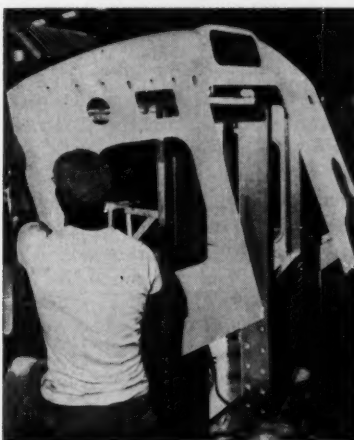
Built of stainless steel and with one-piece end sections of glass-reinforced Hetron® polyester, the new cars save on power because they weigh about three tons less than conventional cars.

They won't ever need painting. End sections are dentproof and virtually shatterproof. The Hetron material retards fire, and corrosion isn't expected to be a problem.

Ends of the cars were made by hand layup at Modular Molding Corp., which delivered the first unit just one month from start of tooling. Section

thickness and rigidity were controlled by adding extra plies of fibrous glass where needed during layup. Gray metallic color was molded in.

Hetron is tough enough for just about any structural assignment you want to give it. Inherent fire safety—



THE BUDD COMPANY

without loss of other physicals—qualifies it for many jobs other polyesters can't do. If you'd like facts on what's being done with Hetron today, just check the coupon.

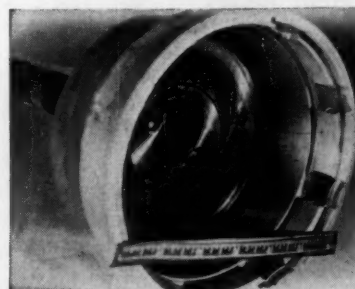
Strong stickum

Are the old ways of joining metal and metal good enough for you? Then prepare for a mild shock as you look at this picture.

It's the housing of an automotive torque converter, joined to the output shaft by a thin film of thermoset cement. The converter has just undergone torsional tests that wrecked its mechanical parts—with no effect whatever on the metal-to-metal bond. Loud

applause for the Cycleweld Chemical Products Division of Chrysler Corporation for this prodigious bond!

A similar cement, made of nitrile rubber and Durez phenolic resin, cut



CYCLEWELD CHEMICAL PRODUCTS DIVISION
CHRYSLER CORPORATION

the cost of assembling an all-aluminum truck tailgate from \$15.18 to \$1.75, by eliminating 211 rivets and 42 welds.

Other heat-setting cements show promise for:

- Building new strength and quietness into car doors, deck lids, and hoods by edge-bonding instead of tack welding.
- Attaching metal trim without drilling holes.
- Easy-to-cast aluminum engine heads and intake manifolds, made in two sections bonded together with a leak-proof, heatproof seal.

We don't make these super-stickers ourselves. We merely supply the phenolic resins that give them many of the qualities a good structural adhesive must have, including permanent rigid set and heat resistance. If you'd like to know where you can get adhesives made with our resins, we'll be glad to tell you.

For more information on Durez materials mentioned above, check here:

- ☐ *Durez 13856 Black* phenolic molding compound (4-page bulletin)
- ☐ Hetron fire-retardant polyesters (designer's data file)
- ☐ "Durez Plastics News" (a review of current plastics applications, mailed bimonthly)

Check, clip and mail to us with your name, title, company address.

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HOOVER CHEMICAL CORPORATION



THE ENGINEER'S Library

Recent Books

ASTM Standards on Copper and Copper Alloys. Sponsored by ASTM Committee B-5; 746 pages, 6 by 9 in., clothbound; published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; available from MACHINE DESIGN; \$9.25 per copy postpaid.

This compilation contains 134 standards of which 37 are new, revised or have had their status changed since the previous edition in 1959. In addition to standards for cast and wrought copper and copper alloys, the book contains some material on nonferrous materials for electrical conductors, certain selected specifications on nonferrous metals and alloys for primary forms of copper, zinc, lead,

and nickel used in copper-alloy products.

Typical of the topics covered are copper and copper-alloy plate, sheet, strip, and rolled bar. In addition rods, shapes and die forgings as well as wire, pipe, tubes, and ingots are included.

An Introduction to the Theory and Practice of Transistors. By J. R. Tillman and F. F. Roberts; 340 pages, 5½ by 8½ in., clothbound; published by John Wiley & Sons Inc., 440 Park Ave. South, New York 16, N. Y.; available from MACHINE DESIGN; \$8.00 postpaid.

Basic properties and applications of transistors are discussed. Part 1 deals with the electronic properties of homogenous semiconductors, isolated p-n junctions, and the interaction between the pair of junctions which make up the transistor. The role of surfaces is emphasized in analyzing a model of a transistor combining an active base region with lateral diode subregions. Part 2 covers the preparation of monocrystals of germanium and silicon of controlled purity, and outlines techniques used to produce junction de-

vices. Quantitative circuit design in the fields of amplification, oscillation, switching, logic, and waveform generation is included.

Antenna Engineering Handbook. Edited by Henry Jasik, Jasik Laboratories Inc.; 1040 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y.; available from MACHINE DESIGN, \$22.00 postpaid.

This handbook provides a compendium of antenna design data and principles. Material is organized into four major parts: Properties and fundamentals, antenna types and methods, applications, and associated topics. Properties and fundamentals cover basic relationships common to all antennas such as radiation patterns, polarization, gain, impedance, and bandwidth. Antenna types and methods include linear antenna elements; long-wire antennas; loop, helical, horn, and slot antennas, passive reflectors, lens type radiators, scanning antennas, and frequency-independent antennas. Applications include low-frequency antennas, medium-frequency broadcast, high-

ENGRAVED PARTS

by WM. A. FORCE

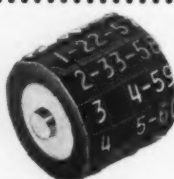
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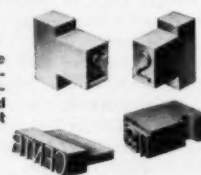
WHEELS

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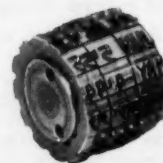
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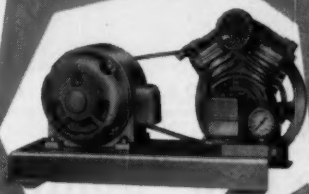
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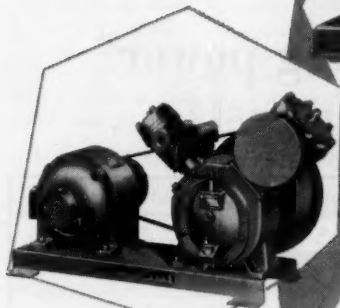
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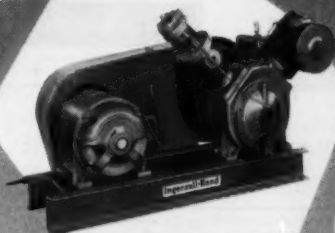
Pick your Pressure for any Purpose



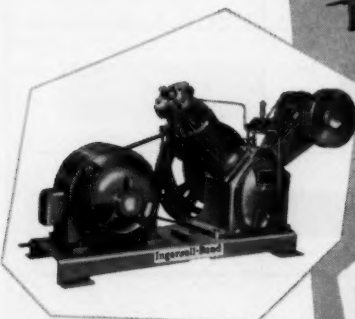
Ingersoll-Rand Model B
Single-stage ¼ hp
10 to 150 psig



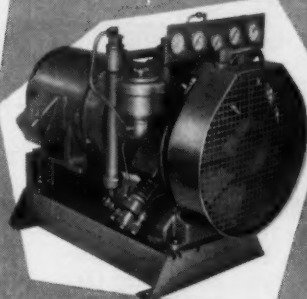
Ingersoll-Rand Model 7TX
Two-stage 7½ hp, baseplate mounted
100 to 250 psig



Ingersoll-Rand Model 7T2
10 hp, up to 500 psig operation



Ingersoll-Rand Model 41X5
5 hp, pressure rating to 1000 psig



Ingersoll-Rand Model 4R15MX
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Technical-ities

By Fred E. Graves

No difference between hex and cap screws

It's not the *name* of a standard fastener that determines whether to use it for a particular application, but vice versa. The *application* requirements for strength and tolerances dictate the fastener.

Thus, if you have a joint that calls for certain tolerances in a screw, obviously the one which satisfies those tolerances is the right fastener.

IDENTICAL STANDARDS

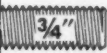

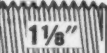
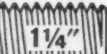
In the case of cap screws and hex screws, the standards will show you that these are merely different names for the same product. They're actually made on the same machines, to identical tolerances, and from identical materials.

No reason then to differentiate. For tapped holes, merely specify Hex Screws (SAE Grade 2) or High Strength Hex Screws (SAE Grade 5), and you'll get the *right* fastener with the quality needed.

For bolted joints, these same items are supplied with nuts when specified.

This should suggest a way you can extend standardization in your plant . . . and benefit from our new simplification of nomenclature which calls *any* fastener with head on one end and threads on the other a *screw*; and a screw plus nut a *bolt*.

See how "holding power" can cut fastener costs

SIZE	SAE GRADE	SAE PROOF LOAD	COST RATIO
 3/4"	Gr. 5	28,400 lbs.	100%
 1"	Gr. 2	16,950 lbs.	188%
 1 1/8"	Gr. 2	21,350 lbs.	239%
 1 1/4"	Gr. 2	27,100 lbs.	277%

Since the usual job of a threaded fastener is to hold an assembly tightly together, its *clamping force* is what you're really utilizing. This seems obvious. But how best to get the clamping force needed for the joint design? Not so obvious. Looking at size alone can be misleading . . . and quite costly, as the chart above demonstrates.

HOLDING POWER MEANS MORE THAN SIZE

SAE "proof load" of four different hex screws of standard steels, along with typical cost ratios, are compared. Almost unbelievable, isn't it? Yet it's a fact that the smallest of the group—the heat treated SAE Grade 5 *RB&W High Strength Hex Screw* exceeds all the others in load capacity. It can be used in place of any of the others in most normal usages.

Since it's smallest and therefore weighs the least, it also costs less . . . 64% less than the 1 1/4-inch grade

2 hex screw; 58% less than the 1 1/8-inch; 46% less than the 1-inch. And since holes can be made smaller, there are also the savings in production drilling . . . and possibly in materials, too.

DESIGN ADVANTAGE

Remember, too, that smaller fasteners are more easily torqued to higher preload levels . . . which helps keep joints tight, makes them more vibration-proof.

If you would like to explore this approach to fastener economy and better utilization of "holding power," consult with an RB&W specialist. Let him contribute his fastener knowledge to your design and production needs. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

frequency arrays, TV and FM transmitting antennas, radar antennas, and radio-telescope antennas. Associated topics are presented on transmission lines and waveguides, impedance matching and broadcasting, radomes and absorbers, radio propagation, and mechanical considerations in antenna design.

Handbook of Fluid Dynamics. Edited by Victor L. Streeter; 1,240 pages, 6 by 9 in., clothbound; published by McGraw-Hill, 330 West 42nd St., New York 36, N. Y.; available from MACHINE DESIGN; \$24.00 postpaid.

This book, divided into two parts, presents a compendium of fluid flow principles, theory, methods, and allied data. The first part deals with fundamental concepts and the second is devoted to applied fluids. Discussed in the first part are fluid flow, laminar flow, flow with chemical reaction, compressible flow, and cavitation. Applications include the fields of hydraulic power, propulsion, aerodynamics, and petroleum production. Other subjects covered are turbulence, motion of immersed and

floating bodies, two-phase flow, flow measurements, sedimentation, turbomachinery, and pipelines.

ASM Review of Metal Literature, 1960. Edited by Marjorie R. Hyslop; 1421 pages, 6 by 9 in., clothbound; published by American Society for Metals, Metals Park, Novelty, Ohio; available from MACHINE DESIGN; \$25.00 postpaid.

This volume contains 11,903 annotations of articles, technical papers, reports and documents appearing in engineering, scientific and industrial journals and books throughout the world in 1960. It is divided into 20 sections covering various areas of materials and process engineering and includes addresses of publications as well as comprehensive subject and author indexes.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

TN D-864. Experimental Method of Producing Porous Tungsten for Ion Rocket Engines. By Neal T. Saunders, Lewis Research Center; 23

pages, 7½ by 10½ in., paperbound, stapled; \$0.75 per copy.

Effects of particle size and sintering temperature on the permeability of tungsten ionizers were investigated. Tungsten powders of 1, 10, and 20 microns average particle size were sintered at temperatures ranging from 2250 to 2900 F. Results from density measurements, metallographic examination, and nitrogen flow tests are included.

PF 161212. Physical Properties of Martensitic Stainless Steels. By J. G. Hoag and D. B. Roach, Battelle Memorial Institute; 32 pages, 8½ by 11 in., paperbound, stapled.

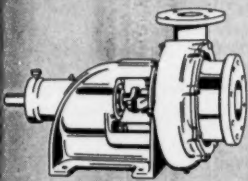
This report summarizes physical property data on martensitic stainless steels. The following AISI types are considered: 403, 410, 414, 416, 420, 431, and 440. Values are given for properties of density, specific gravity, melting point, specific heat, thermal conductivity, linear thermal expansion, thermal diffusivity, electrical resistivity, modulus of elasticity, and modulus of rigidity.

TN D-693. Charts for Air-Flow in Hypervelocity Nozzles. By Kenneth K. Yoshikawa and Elliot D. Kaizer, Ames Research Center; 70 pages, 7½ by 10½ in., paperbound, stapled; \$1.75 per copy.

Air-flow properties in nozzles are charted for equilibrium flow and two types of frozen flow. Calculations were made for a range of stagnation pressures up to 10,000 psi absolute and stagnation enthalpies up to 24,500 Btu per lb. Flow properties charted are temperature, pressure, density, velocity, dynamic pressure, Mach number, Reynolds number, molecular weight fraction, and mass flow.

PF 161799. Mechanical Properties of Titanium Alloys as a Function of Heat Treatment and Section Size. By Charles F. Hickey Jr., Watertown Arsenal Laboratories; 62 pages, 8½ by 10½ in., paperbound; \$1.75 per copy.

The mechanical properties of 6Al-4V, 6.5Al-3Mo-1V, and 6 Mo-3Al titanium alloys were obtained as a function of section size and heat treatment. Optimum heat treatment for investigated conditions was established for each alloy. Other factors, such as specimen location, directionality, and microstructure, are discussed.




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- Positive Hole Fill
- Easy Installation

For fast, secure, more economical fastening, the new Cherry Commercial Rivet is a blind fastener ideal for production manufacturing and repair. Installed by one man from one side of the work, the Cherry Commercial Rivet reduces cost of assembly, repair and maintenance in both blind and open applications.

Minimum blind side clearance, adaptability to variations in material thickness, and positive hole fill even in oversize or out-of-round holes offer advantages not available in other production fasteners.

Cherry Commercial Rivets are available in both hollow (non-structural) and plugged (structural) types. The plugged rivets have strength values comparable to solid rivets, and stems fracture to eliminate all trimming operations and provide further production economy.

Grip lengths from $\frac{1}{8}$ " to 1" inclusive, and diameters of $\frac{1}{8}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ " and $\frac{1}{2}$ " are provided in either universal or countersunk head. Special rivets are manufactured to order.

For full technical information on the new Cherry Commercial Rivet, write Cherry Rivet Division, Townsend Company, Box 2157-E, Santa Ana, California.

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The Bearings Book, 1961 Edition (256 pp.) \$2

The Seals Book, 1961 Edition (240 pp.) \$2

The Fasteners Book, 1960 Edition (236 pp.) \$2

Preventing Fatigue Failures, by F. B. Stulen, H. N. Cummings, W. C. Schulte, 1961 (32 pp.) \$1 (available Aug. 1)

Simplified Vibration Analysis by Mobility and Impedance Methods, by R. P. Thorn & A. H. Church, 1959-60 (80 pp.) \$2

Inside the Engineer, by Eugene Raudsepp, 1958-1960 (52 pp.) \$1

Mobility of Cross-Country Vehicles, by M. G. Bekker, 1959-1960 (32 pp.) \$1

Engineering Approach to Hydraulic Lines, by Jaroslav J. Taborek, 1959 (36 pp.) \$1

Planning New Products, by Philip Marvin, 1953-1958 (102 pp.) \$3

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Electronic and Electric Power Supplies, (Symposium) 1958 (40 pp.) \$1

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Mechanics of Vehicles, by Jaroslav J. Taborek, 1957 (94 pp.) \$2

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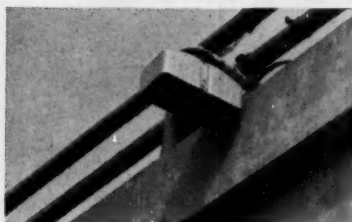
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ECHOES IN THE INFRARED TRIP A TRAFFIC SIGNAL

Your car passes under a compact little unit hanging over the road and—presto—up ahead a traffic signal changes to green.

There are two devices in the unit which is fabricated by Infrared Industries of Waltham, Mass. One emits a beam of infrared down at the pavement *via* a special glass lens which we supply. The second device receives the echo sent back when a car passes through the infrared beam. The beam bounces back up through another Corning lens, off a silvered reflector (also ours), and onto a cell which activates the unit. The unit in turn activates the traffic signal or just keeps track of the traffic.

If you happen to spot one of these devices on a drive and still have to stop for a red light, do not despair. Take those few seconds and consider the red, yellow, and green roundels on the traffic light itself. That's right, we make those too, and it's quite a trick, since we have to mass produce those roundels by the thousands, holding to some of the most rigorous color standards you've ever seen.

All of this adds up to a good story on the passing of light—visible or invisible—through glass. We have the capabilities. If you have the problems, perhaps we can get together and produce some products.

We'll be glad to send anything you ask for in the coupon.



A FEW FREE SUBSCRIPTIONS TO GLASS TALK STILL LEFT

Like many of our worlds, the world of glass continues to grow at a breathless pace . . . adding more and more exotic, but eminently useful, glass products every month.

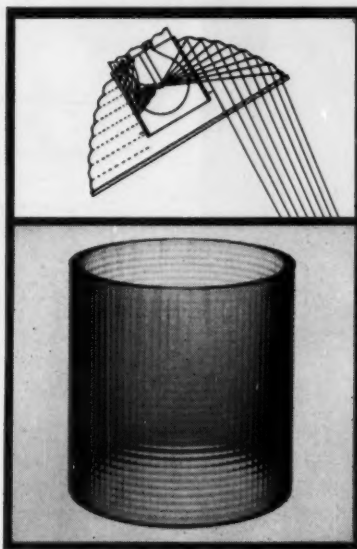
To keep people like you up to date on what's being done, we put out a bi-monthly (more or less) publication called *Glass Talk*. The economics of printing are such that we can add a number of new names to our mailing list without upping costs greatly.

So, if you think glass has a place in your future, send us your name and address on the coupon. Naturally, *Glass Talk* is gratis.

NEW BLUE AKLO® CYLINDER ABSORBS 99+% OF IR

If there's ever a man you want to keep comfortable, it's a surgeon. So, you take extra pains with his lighting.

You want to correct his light to daylight. You want both him and his patient to stay as cool as possible.

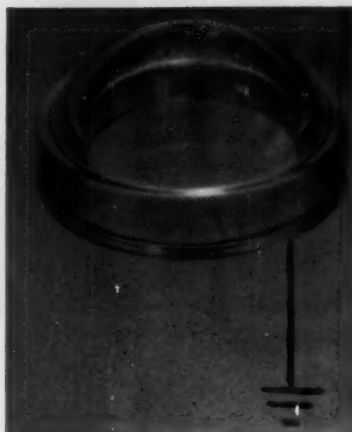


A new AKLO filter which we make does both. It takes 2900°K light from incandescent lamps and corrects it to 4000°K. It absorbs all but a niggling less than 1% of the lamp's infrared, hardly enough to raise the temperature of a flea.

Add this to a cylinder that has been designed to be used with clear lamps and you get smooth, reproducible results every time the unit is relamped.

Filtering like this recommends itself for lighting, for photoengraving and photography, theaters, movies, television—in short, any place where you have light- and heat-conscious customers.

Check the coupon, if you're interested.



GROUNDING GLASS

One of the old bugaboos of using glass in conjunction with extremely sensitive electronic devices—static charging—should bother you no longer.

We can supply a variety of shapes with an electroconductive coating which you can run to ground. And static charge drains off as soon as it forms, so there's no danger of outside signals throwing your device into a tizzy.

The same method also eliminates the nuisance noise broadcast by fluorescent tubes. We make a glass shield which looks like a regular lighting panel except that it, too, has a grounded electroconductive coating.

Think about this glass for a minute and you'll see there are many other equally sensible applications.

Run a current through a piece of it, for example, and you have a warm piece of glass . . . perfect for self-defrosting mirrors or windows.

You'll find that certain glasses become efficient infrared emitters when you run a current through an electroconductive coating . . . great for space heaters or driers (both of which we make).

Turn the glass around and cut off the current and you find that it *reflects* infrared while passing visible light. That makes an excellent heat shield.

Send the coupon for the full story on our electroconductive glasses.



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TRS Perma-Nuts®

Edwin F. Guth's modern recessed lighting fixture uses two Perma-Nuts as combination sliding bearings and threaded fasteners for slotted hinge-cover arms. Replacing separate nuts and sleeve bearings, they simplify design, cut assembly time.

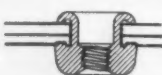


You can have your cake and eat it too, if you use Perma-Nuts — the unique TRS internally-threaded tubular rivets. Here, one Perma-Nut does the job of separate nut and bearing. In most applications, Perma-Nuts also give you the simplicity, speed and economy of automatic riveting, because they can be fed and set with standard automatic machines just like rivets. Strong, clean threads, entirely within the head, give plenty of screwholding power. Serrations under the head act as a built-in lockwasher. The head itself takes no more room than a standard hex nut of the same thread size, and nine standard thread sizes are available, from #3-48 to 1/4-28, in steel, brass or aluminum.

Think how often you'd like a rivet and a nut in one piece and one place. With a Perma-Nut, you've got it. Let your TRS man tell you the full story. Find him in the "Yellow Pages," or write us. Send for Perma-Nut catalog.



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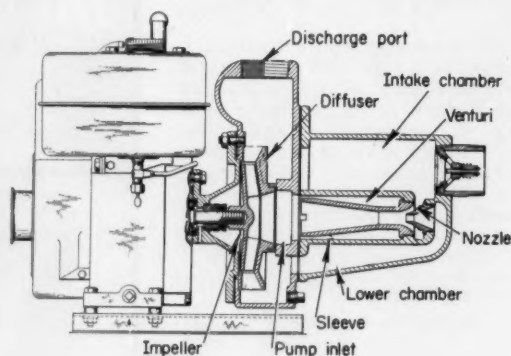
QUINCY 70, MASSACHUSETTS

NOTEWORTHY

Patents

Dual-Pressure Pump Attachment

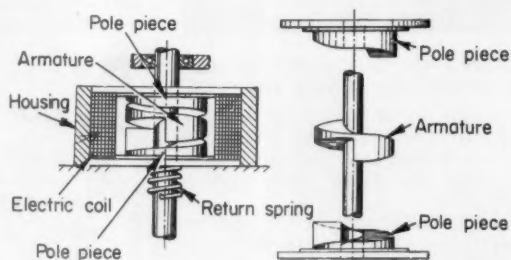
A pump feed attachment has two mounting positions to provide either a jet feed for boosted output pressure or a direct feed for normal output pressure. The attachment, located on the side of the pump, is divided into an upper fluid-intake chamber and a lower pressure chamber. Divider walls define a jet-feed outlet which leads to the main pump suction. When the casing is



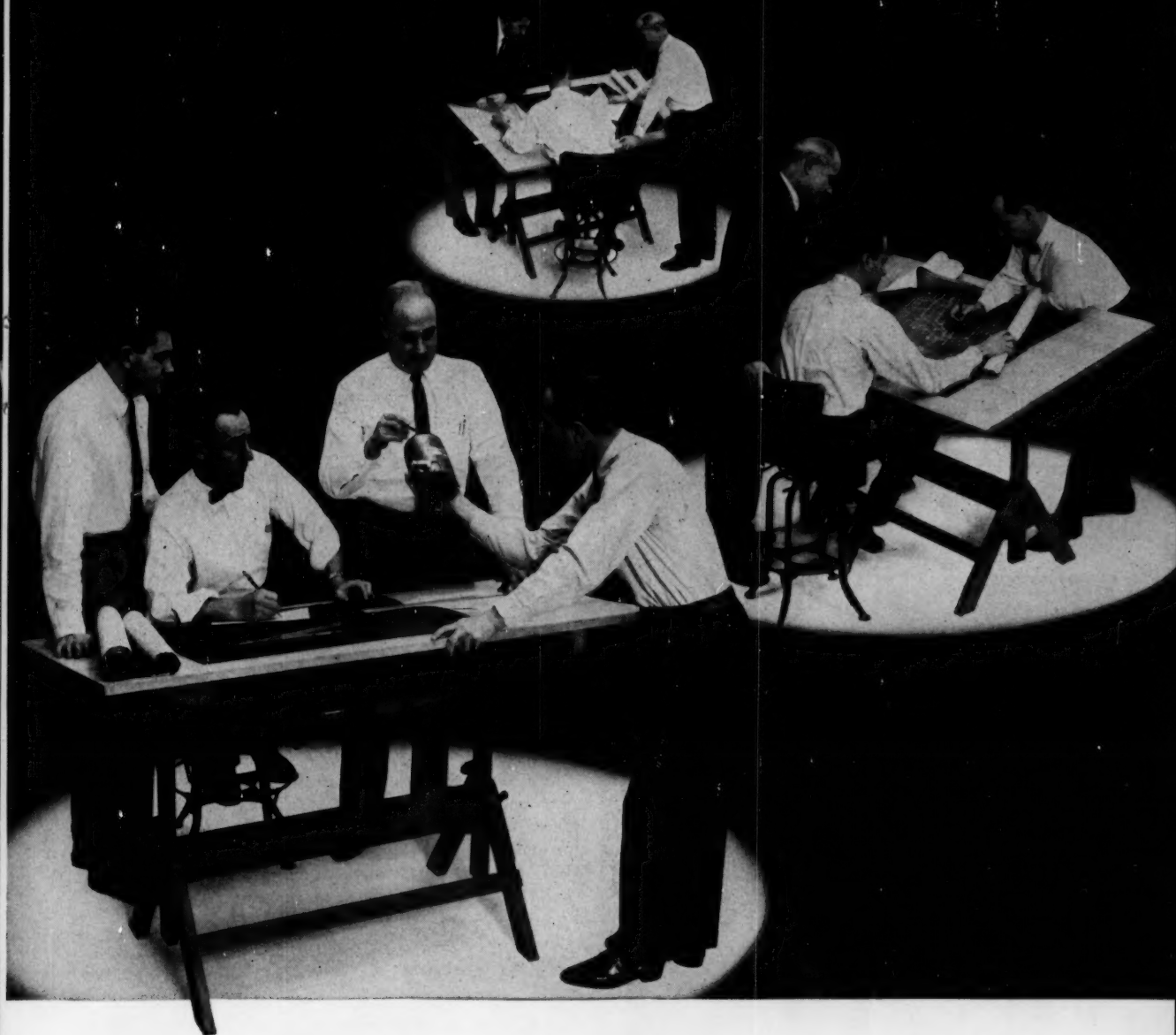
in the position shown, the normal feed passage is blocked, and the stream of fluid pressure directed through the venturi serves to provide a high-pressure jet boost. When the casing is shifted to the alternate position, the normal feed opening is aligned with the inlet opening of the pump housing and the jet feed passage is sealed and blocked by the outside surface of the pump. Patent 2,987,002 assigned to Sta-Rite Products, Inc., Delavan, Wis., by James Schipper.

Rotary Actuator

A rotary helical actuator provides relatively high torque for a limited electrical input. Actuator is comprised of a pair of opposed pole pieces and armature



surrounded by an electric coil. The facing ends of the two pole pieces are formed in a helical shape which



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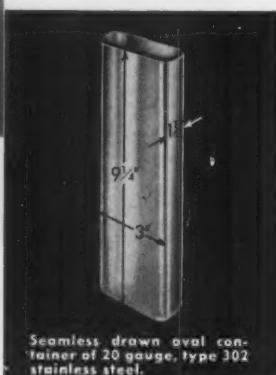
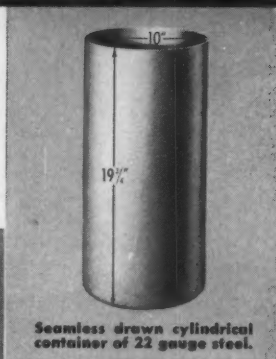
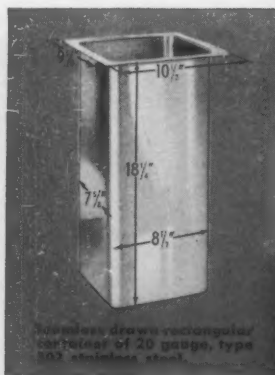
Lamb Electric

**SPECIAL APPLICATION
FRACTIONAL HORSEPOWER MOTORS**

Circle 385 on Page 19

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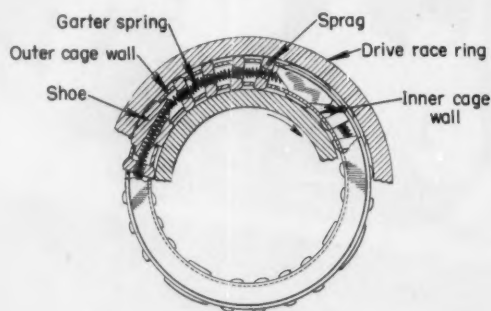
4500 Lake Shore Road—Sheboygan, Wisconsin

NOTEWORTHY PATENTS

conforms to the mating faces of the armature. The assembly is much like that of a screw since the armature faces advance relative to the pole pieces. However, the shaft is held against axial movement by the shaft bearing. Changes in helical angle or lead length affect the output torque and may be varied to produce the particular torque desired. *Patent 2,987,657 assigned to North Atlantic Industries, Westbury, N. Y., by Arthur J. Buchtenkirch and Malcolm D. Widenor.*

Sprag Clutch

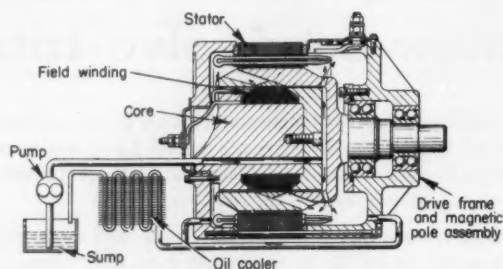
Concentricity of inner and outer races in a uni-directional clutch is maintained by four Kingsbury type shoes. Driving engagement is effected by sprags which become wedged between the races when the inner race



is rotated in the driving direction. Spacing between sprag cage and inner and outer raceways is maintained by Kingsbury shoes to prevent dragging and unequal gripping engagement of sprags. *Patent 2,987,154 assigned to General Motors Corp., Detroit, Mich., by Leland D. Cobb.*

Brushless Generator

Stationary field and stator windings eliminate the need for brushes or slip rings in an ac generator. This effect is achieved by rotating a magnetic-pole assembly



between the stationary stator and field windings. In operation, a dc voltage is connected to the field winding to produce a magnetic flux in the core. Turning the rotor through one pole pitch reverses the flux direction in any given part of the stator iron. Therefore, continued reversals by continuous turning generate



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SKF is a leader in the development and application of ultra-precise measuring systems. The SKF metrology laboratory plays an important part in a continuing program of research to produce bearings of improved accuracy and finish, and consequently, quieter, smoother running characteristics.

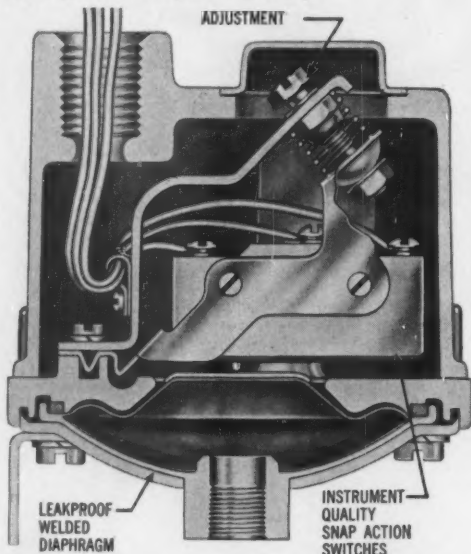
Whatever types of rolling contact bearings you need—ball, cylindrical roller, spherical roller, tapered roller or precision miniature—you'll find SKF your best assurance of dependable performance. SKF Industries Inc., Philadelphia 32, Pa.

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Circle 387 on Page 19

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which saves the installation costs encountered in mounting a switch that uses liquid switching elements

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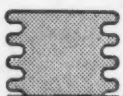
which, as they wear, make the setting of the pressure switch drift.

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which make the switch difficult to mount and very critical to vibration.

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which make the pressure switch sensitive to vibration.



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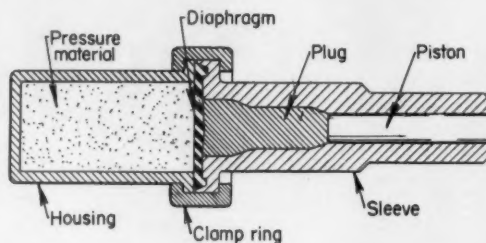
5125 Alcoa Avenue, Los Angeles 58, California

NOTEWORTHY PATENTS

an ac voltage. The cross-sectional area and length of the iron paths and air gaps traveled by the flux and, hence, the reluctance of the magnetic circuit, remain essentially constant during rotation of the rotor assembly. The unit is cooled by feeding oil between the stationary field and magnetic-pole assembly so that oil is centrifugally forced into the stator windings. Patent 2,987,637 assigned to General Motors Corp., Detroit, Mich., by Ralph H. Bertsche and Eldred E. Gegenheimer.

Plug-Actuated Power Element

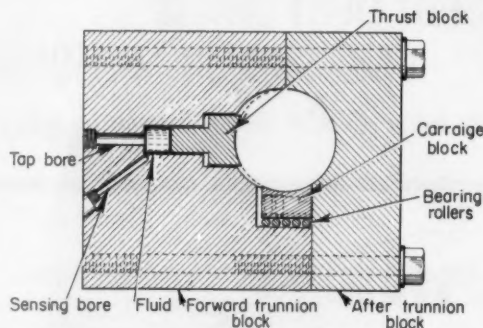
A deformable rubber plug multiplies movement of a pressure core in a power element. The power element comprises a diaphragm and plug located between the piston and the core which is made of a thermally expandable material. When pressure increases (from



increased ambient temperature) the multiple-step plug is squeezed through the tapered portions of the sleeve. This squeezing causes the plug to become elongated so that the piston moves a greater distance than the surface of the pressure core. In addition, the plug walls are pressed tightly against the interior side walls of the sleeve to seal the power element during return movement of the piston. Patent 2,986,936 assigned to Antioch College, Yellow Springs, Ohio, by Sergius Vernet.

Carriage-Supported Trunnion Mount

A roller-mounted carriage, housed within a trunnion assembly, carries static and side loads with minimum friction. The assembly is comprised of two comple-



mentary blocks joined together by bolts. The carriage rests on a number of transverse rollers in the forward



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PAT. PENDING

Eliminates leaks in oil, air, water, vacuum, chemical lines

Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily—without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—without the use of pipe dope. Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.

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Circle 389 on Page 19

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Circle 390 on Page 19

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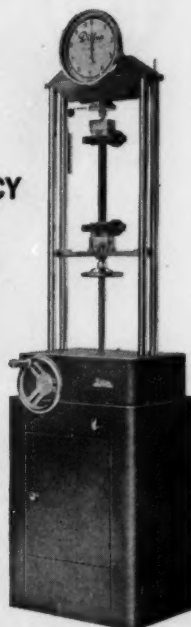
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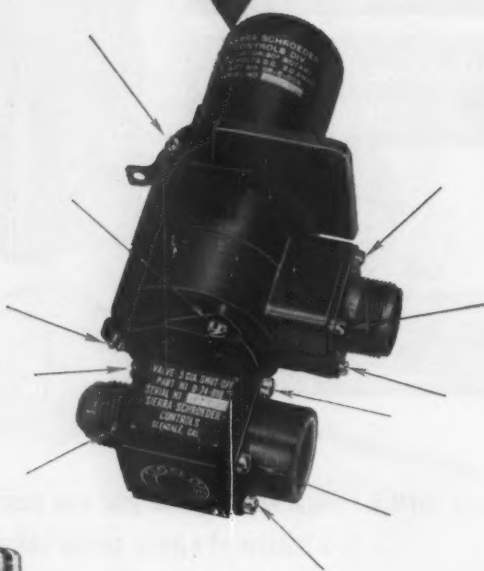
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Circle 391 on Page 19

257

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Available in all head sizes and styles—have wide temperature range—qualified to MIL-F 18240 specifications—head marked for self-lock identification.

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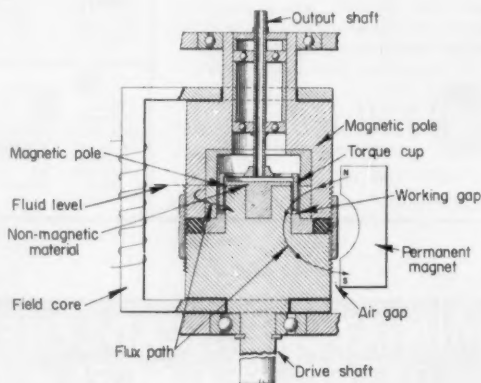
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NOTEWORTHY PATENTS

block and is spaced from the end walls by side rollers which are positioned in a vertical plane. The trunnion is therefore free to move back and forth on the carriage. The forward block also contains a cylinder perpendicular to the trunnion bore. A fluid-loaded piston housed within the cylinder has an enlarged end and constitutes a thrust block. A tap bore from the cylinder leads to an indicator for remote reading of thrust load. *Patent 2,986,930 assigned to Ryan Aeronautical Co., San Diego, Calif., by Hillard S. Price.*

Magnetic-Fluid Clutch

Magnetic fluid, such as iron powder suspended in oil, "stiffens" in the direction of magnetic flux to engage input and output clutch members when an electric signal is applied from a signal coil. This stiffening locks a "torque cup" on the output shaft between the drive shaft and clutch housing. The housing is



composed of a lower drive-shaft section attached to an upper section by a ring. The torque cup on the output shaft is supported by ball bearings. This cup extends down into the magnetic fluid and leakage is prevented by a liner ring and O-ring seal. A non-magnetic member fits directly underneath the torque cup to maintain the magnetic flux path through the magnetic poles. *Patent 2,987,153 assigned to Texas Instruments Inc., Dallas, Tex., by Edward Gordon Perry.*

Constant velocity universal joint operates over a wide angle and can accommodate axial slip. Joint comprises trunnion and bearing assemblies housed within two cylindrical chambers. One of the chambers is allowed to move axially with the connecting shaft. Centering of the joint is accomplished by a crosspin extending through the connecting shaft and riding in a spherical stamping in the chamber section. *Patent 2,981,084 assigned to General Motors Corp., Detroit, Mich., by Earl W. Glover.*

Copies of patents briefed in this department may be obtained for 25 cents each from the Commissioner of Patents, Washington 25, D. C.

the "open" entrance

AMERICAN AIR CURTAIN CORPORATION

April 14, 1960

WHY MR. ERNEST GYGAX,
Chief Engineer for
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Ernest Gygax
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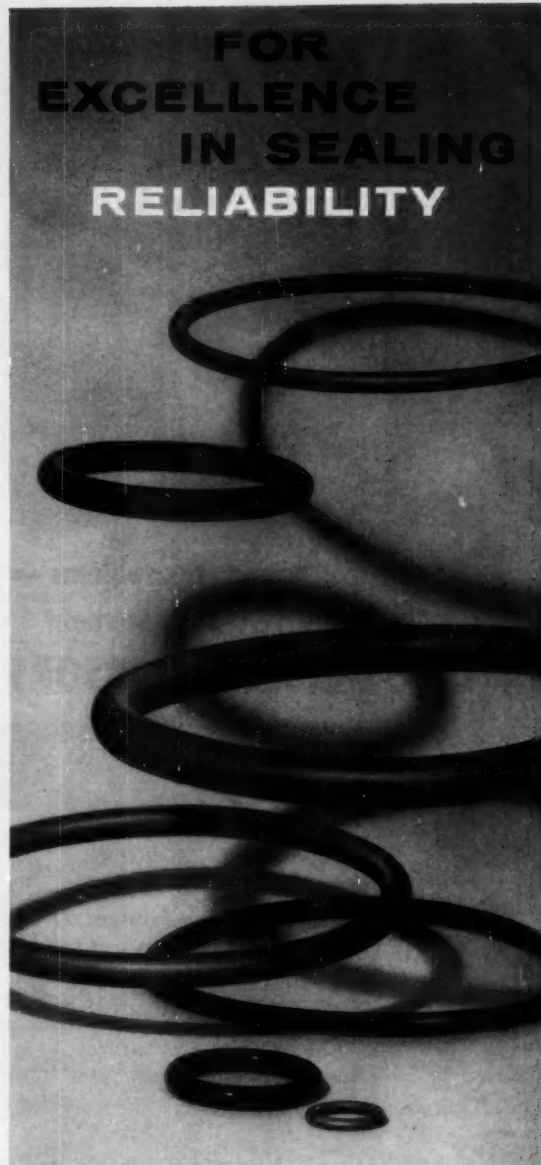


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Circle 393 on Page 19



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Circle 394 on Page 19

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GAST
PRODUCTS**



Model 2065 with motor,
Gast base and coupling.

**Solve your product problems —
specify positive displacement
GAST ROTARY AIR COMPRESSORS**



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0465



Model
1065



Model
2065



Model
4565

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	C.f.m. @ 0 p.s.i.g.	Continuously	Intermittent			
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0765	5.9	10	15	1/2	18	
1065	8.3	25	30	1	33	
2065	17.0	15	20	1 1/2	52	
2565	21.0	15	20	2	51	
4565	45.0	15	20	5	92	

*Without base or electric motor.

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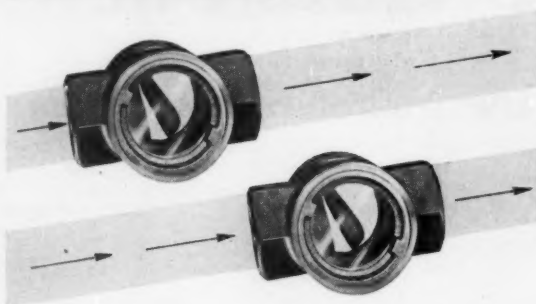
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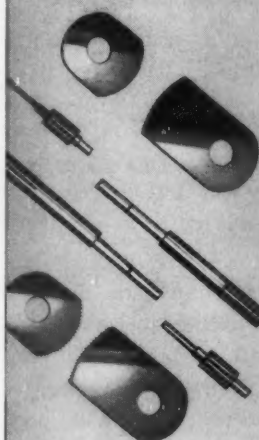
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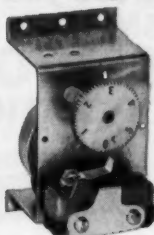
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Instant Fingertip Setting ... For 0 to 120 Second Delays

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Precision synchronous motor drive assures extremely accurate timing and positive action. Unit is ready-to-mount with all components assembled on compact bracket. Operates from any standard voltage source, handles up to 20 amps., 480 V. non-inductive.



Request details today! Write on company letterhead for Bulletin A-17 describing automatic transfer switches, magnetic contactors, special electromechanical controls and timing devices.

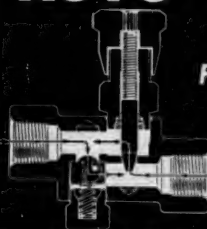


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Flow Control, Needle, Check, for HYDRAULIC Power
Model KF Flow Control Valve with Dial and Knob adjustment for direct reading and duplicating reference. Now available in Aluminum for 3000 psi.

Pat. #2,841,174

A complete line: $1/8$ ", $1/4$ ", $3/8$ ", $1/2$ ", and $3/4$ " female Dryseal Pipe Sizes in all models and types. Equivalent Aeronautical Tube Sizes on special order.

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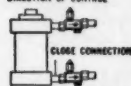
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SENSITIVE, CHATTERLESS BALL CHECK . . . Patented design insures rapid ball movement to open or close at low differentials.

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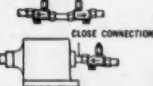
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TWO DIRECTION CONTROL



Controlling Single Acting Cylinder



Model F Standard Flow Control Valve or Model H Needle Valve



Model KF Knob and Dial Flow Control Valve or Model PH Needle Valve for panel mounting

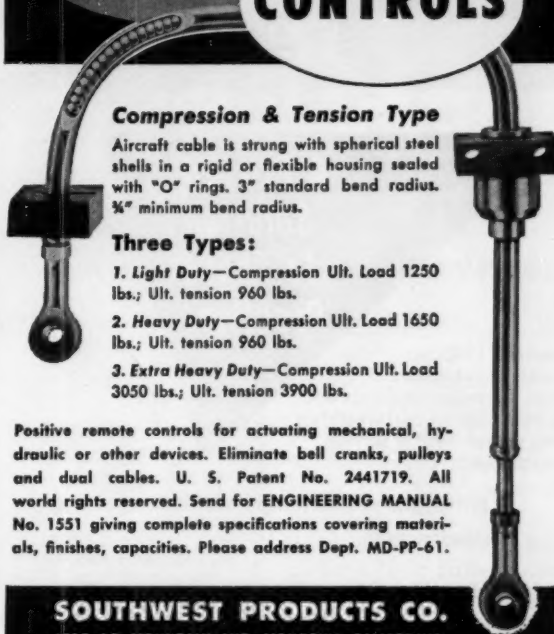


Model C Check Valve for in-line mounting

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BELLWOOD (Chicago Suburb) ILLINOIS

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push-pull CONTROLS



Compression & Tension Type

Aircraft cable is strung with spherical steel shells in a rigid or flexible housing sealed with "O" rings. 3" standard bend radius. $1/4$ " minimum bend radius.

Three Types:

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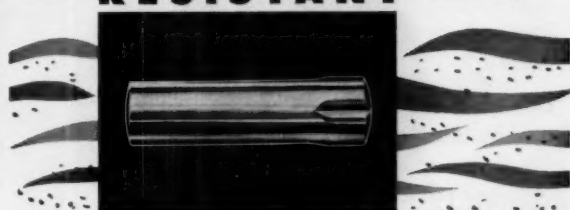
Positive remote controls for actuating mechanical, hydraulic or other devices. Eliminate bell cranks, pulleys and dual cables. U. S. Patent No. 2441719. All world rights reserved. Send for **ENGINEERING MANUAL No. 1551** giving complete specifications covering materials, finishes, capacities. Please address Dept. MD-PP-61.

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Circle 399 on Page 19

need CORROSION RESISTANT fasteners?



Regardless of cost, the best fastening devices aren't worth a cent if corrosion shortens their useful lives. Driv-Lok grooved pins can be produced in a variety of metals and finishes designed to give you a positive lock, lasting through harmful effects of moisture, acids, alkalis, oils, solvents and other chemicals.

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Let us show you how effective, versatile and corrosion-resistant, DRIV-LOK grooved pins can be. Send for your free catalog or give us a call, Sycamore 2148.



DRIV-LOK SALES CORPORATION

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261

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11R51

STAINLESS SPRINGS

*A Proven
Solution
To These
Problems*

Sandvik 11R51 steels' combination of high corrosion resistance and superior spring characteristics has proven itself in springs which must . . .

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OPERATION**



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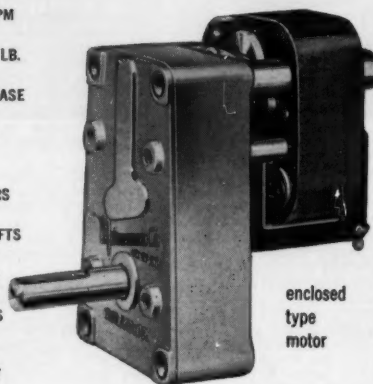
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The **ELECTRO-MECHANO Co.**
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motor

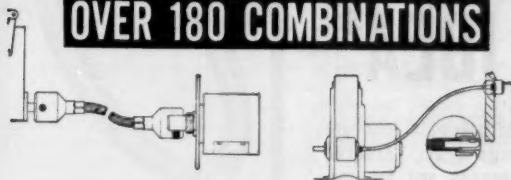
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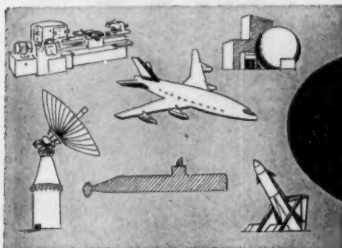
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NUT
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Circle 406 on Page 19

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for all types.**

No matter what type of fitting you require—for hydraulics, pneumatics, instrumentation, lubrication or process piping, FLODAR can furnish the tube or pipe fitting best suited to your individual needs.

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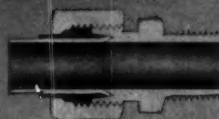
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ARE J.I.C. APPROVED**

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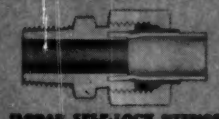


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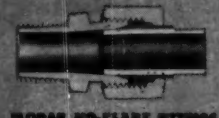
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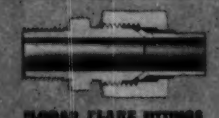
FLODAR SELF-FLARE FITTINGS
Fitting Flares the tube I.D. and O.D. Seal



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For Nylon & Plastic Tube



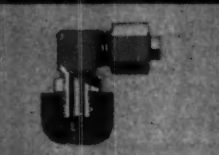
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No Thread, No Flare, No Solder or No Welding



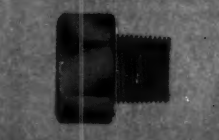
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37° — J.I.C. Standard



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Metal-to-Metal Seal — No pipe threads



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Machine Dry-Seal Threads



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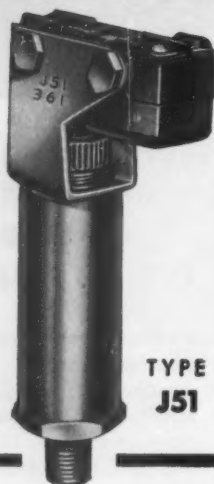
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development of leakproof fluid systems

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263

Wide Range
Space Saving

J51



PRESSURE VACUUM CONTROL

TYPE
J51

United Electric's Type J51 Pressure-Vacuum Control is a skeleton, precision-built unit that is used extensively in applications where space and weight are factors. It has an uncalibrated adjustment that may be provided with locking feature if desired. It is a rugged, wide range control suitable for a multitude of uses.

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Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. Also available are 20 amps. A.C., manual reset, D.C., and other switches.
Switch Types	Normally Open, Normally Closed, or Double Throw — no neutral position.
Maximum Pressure . . .	350 psi.
Electrical Connections . .	Lead wires attached to screw type terminals on switch.
Pressure Connection . .	Via a 1/8" male NPT connection.
Mounting	Via pressure connection.
Bellows Material	Either type 321 or 347 stainless steel.

UNITED ELECTRIC manufactures a complete line of temperature, pressure, and vacuum controls. For applications requiring custom-built units or modified standard units, call upon a UE application engineer for recommendations. Complete data is available for the Type J51 as well as for all standard UE controls.



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O-rings from selected
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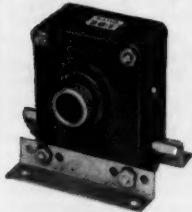


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NEW-TYPE FHP PULLEYS AND SPEED REDUCERS SAVE YOU 33% PER UNIT

You can now cut costs on fractional horsepower equipment of all kinds with these unique, metal and nylon-fiberglass products. Rampe Variable Pitch Pulleys and Speed Reducers wear longer, run quieter, and cost less. Savings are 33% or more per unit in lower initial cost and added chemical resistance, impact strength, self-lubrication for hard-to-reach applications.



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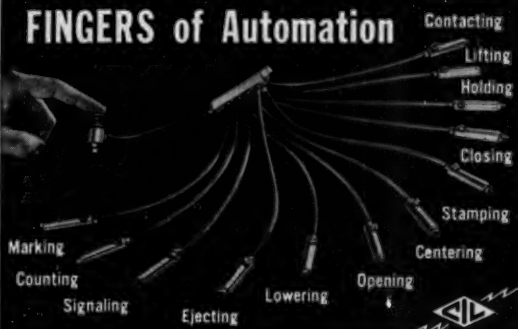


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Circle 412 on Page 19

Send your toughest threaded *loosener* fastener problems to Nylok

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Only Nylok has the patented principle which can be applied to *any threaded joint*... male or female, any shape, any size, any material... to make it:

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Circle the indicated number on the Reader Service Card, and we'll send you a copy of our 24 page catalog, giving complete, basic product and application data.



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265

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designed
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You send us a blueprint, sketch or rough sample of the spring that you need (giving complete information as to how the part will function), and CF&I engineers will design and produce several prototypes for you.

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Send replies outlining education, experience, and salary desired to A. J. Nelson.



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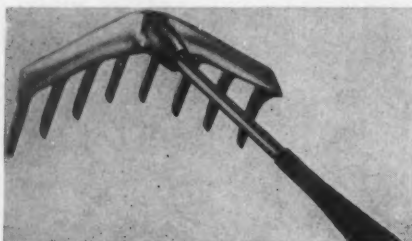
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backtalk—

—Peace Crops

Our man in England who sends us engineering news from his island recently included a nontechnical item which we nevertheless feel deserves a mention. The thing is called a Wrake



and is used in the garden—for raking, cultivating, soil levelling, and the like. The Wrake's swept-back design allows cultivation close to plants and prevents spillage of soil being raked. Significant is the tool's swords-into-plowshares background: It's made by Wilkinson Sword Co. Ltd. We're told the Wilkinsons were very good at swords. It appears they have developed a wreatly wrevolutionary Wrake as well.

—Something New

We put the Wrake on this page because we feel it is of personal rather than professional interest to MACHINE DESIGN's audience. However, some other, more practical examples of industrial design appear on Page 32, beginning a new feature in the Engineering News section. "Industrial Design—comments and configurations" aims to present just that—pictures and words pertaining to the field of industrial design, to keep you informed and to inspire. Undoubtedly you'll find ideas on these pages; we do hope, though, that no one will be moved to design a bus with those crazy suction-cup seats. (No offense, Mr. Kimmell).

—Do You Have a Secret?

Engineers are great short-cutters, and it's safe to assume that most of you employ a number of time and effort-saving techniques every day in your work. This is commendable and

is even more so if you share these good ideas with your fellows. The simplest way to do this is to send your ideas to our Tips and Techniques department. You don't have to know how to calculate cube roots in your head—less startling methods of conserving engineering and drafting energy are expected and accepted.

Send your ideas (with drawings, tables, photographs, et cetera) to Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio. If we publish them, it will give you a warm glow—radiation, perhaps, from the ten dollars or more we send in exchange for each tip.

—Horsepower for Horse Power

To supplement all the useful information published on electric motors (a series on dc motor control begins on Page 154), we submit the following case history. Lamb Electric Co., a division of American Machine and Metals Inc., has built some special-application fractional-horsepower motors for use in "turbolator boots." The boots fit the legs of racing horses, and the motors agitate warm water to administer a hydromassage to those which have spent a hard day at the track.

—Continental Cleanliness

Selling automatic washing machines to European housewives seems like a transaction involving marketing, rather than design engineering personnel. Not so, says Controls Co. of America, in reporting that overseas laundry methods have necessitated modifying and even re-engineering of control systems. The European ladies feel that clothes must be tumbled, so vertical-axis machines had to be altered accordingly. They also say "no soap" to the expensive idea of storing hot water in a tank; therefore their washers must have built-in electric water heaters. This, in turn, requires special modification of cycling controls. Fortunately, these and other discrepancies in tooling, design, and performance specifications all come out in the wash.

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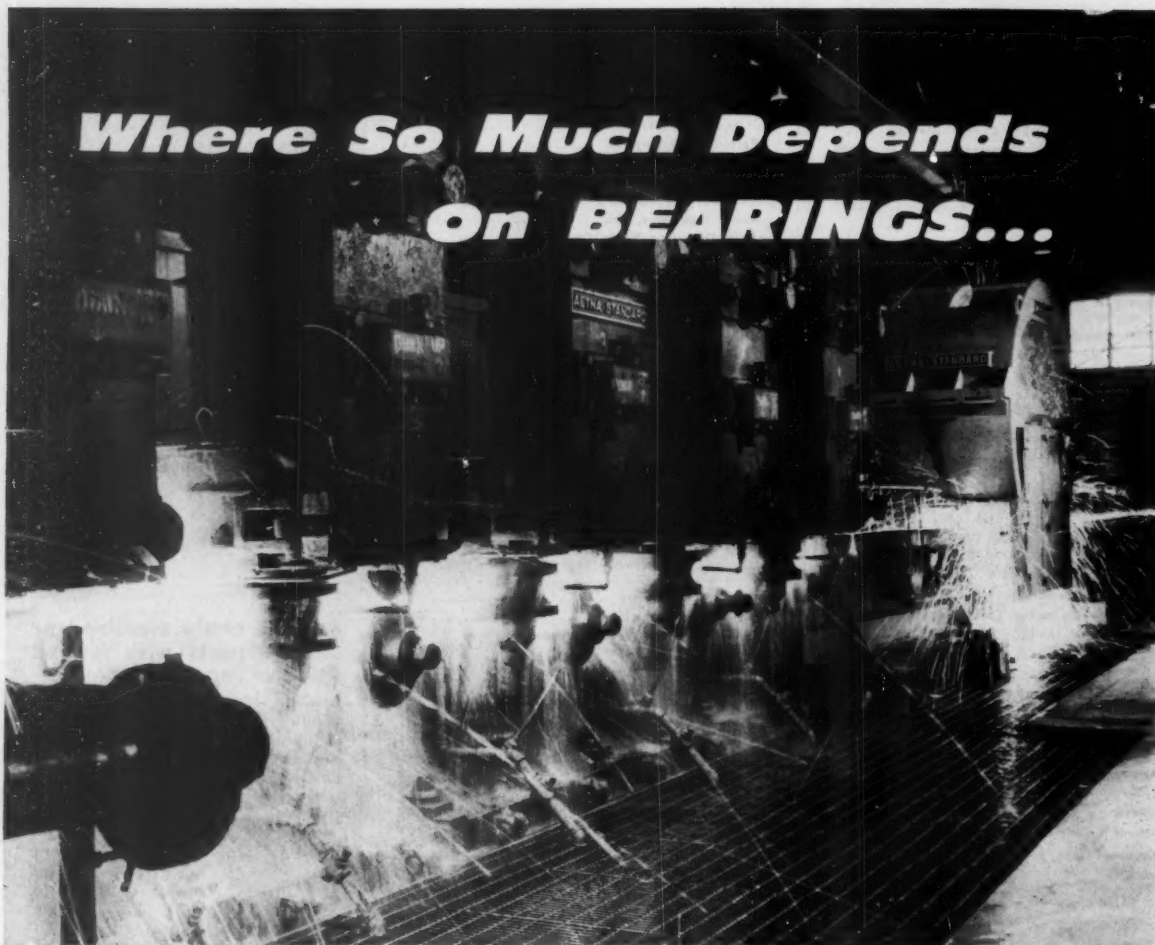
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Circle 416 on Page 19

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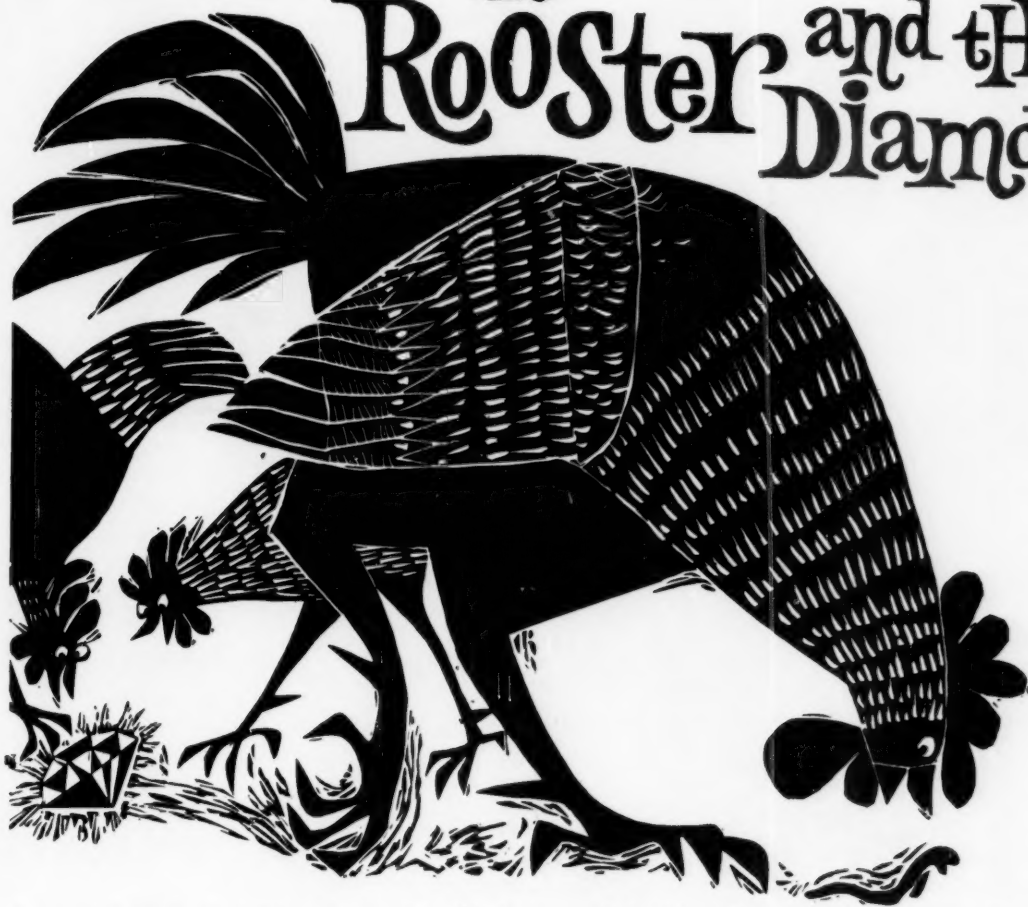
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moral: Don't let fancy outshine value.

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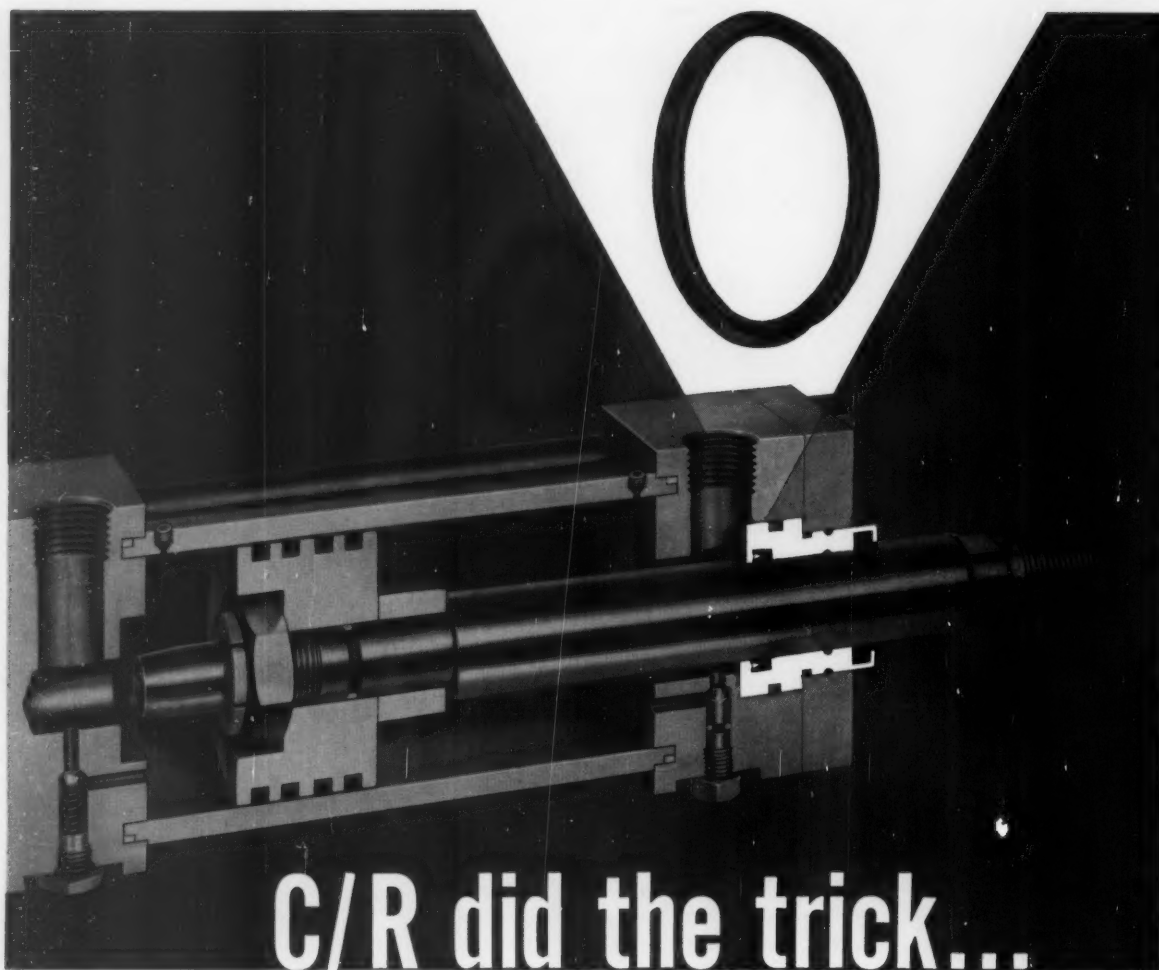
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